

A1-F18AC-SRM-200

1 January 1995

Change 6 - 15 April 2001

TECHNICAL MANUAL

**ORGANIZATIONAL, INTERMEDIATE, AND DEPOT
MAINTENANCE**

STRUCTURE REPAIR

GENERAL INFORMATION

NAVY MODEL

F/A-18A/B/C/D

161353 AND UP

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NATEC ELECTRONIC MANUAL

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4.....	5	18.....	0	5.....	0	7.....	0
5.....	5	19.....	0	6.....	0	8.....	0
6.....	5	20.....	0	7.....	0	9.....	0
7.....	5	21.....	0	8.....	0	10.....	0
8.....	5	22.....	0	9.....	0	11.....	0
9.....	5	23.....	0	10.....	0	12.....	0
10.....	5	24 blank	0	11.....	0	13.....	0
11.....	5	004 00		12.....	0	14.....	3
12 blank	5	1.....	4	13.....	0	15.....	3
001 01		2.....	4	14 blank	0	16.....	3
1.....	5	3.....	4	004 03		16A.....	3
2.....	5	4.....	4	1.....	0	16B.....	3
001 02		5.....	4	2.....	0	16C.....	3
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002 00		8 blank	4	5.....	0	16F.....	3
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3.....	5	2.....	0	004 05		19.....	0
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6.....	5	5.....	0	2A.....	6	22.....	3
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8.....	5	7.....	0	3.....	0	24.....	0
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003 00		10.....	0	6.....	0	27.....	0
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36.....	0	6.....	3	10.....	0	2.....	0
37.....	3	7.....	3	11.....	0	3.....	0
38.....	3	8.....	3	12.....	0	4 blank	0
39.....	3	9.....	3	13.....	0	004 19	
40.....	3	10.....	3	14.....	0	1.....	0
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42 deleted.....	3	12.....	3	1.....	0	004 20	
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46.....	3	16.....	3	5.....	0	4.....	0
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004 07		8.....	3	7.....	0	004 21	
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2.....	0	10.....	3	9.....	0	2.....	3
3.....	0	11.....	3	10.....	0	3.....	3
4.....	0	12.....	3	11.....	0	4.....	3
5.....	0	004 10		12.....	0	5.....	3
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7.....	0	2.....	2	14.....	0	7.....	3
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25.....	0	6.....	0	32.....	0	004 24 reserved	0
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2.....	4	6.....	0	11.....	0	7.....	0

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10.....0		15.....0		7.....0		34.....0	
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12.....0		4.....0		31.....0		10.....3	

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12.....	3	5.....	0	014 00		35.....	0
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21.....	3	7.....	0	9.....	0	3.....	0
22.....	3	8.....	0	10.....	0	4.....	0
23.....	3	9.....	0	11.....	0	5.....	0
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31.....	0	17.....	0	19.....	0	13.....	0
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34.....	0	1.....	0	22.....	0	16.....	0
35.....	0	2.....	0	23.....	0	17.....	0
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37.....	0	4.....	0	25.....	0	19.....	0
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40.....	0	2.....	0	1.....	0	1.....	0
41.....	0	3.....	0	2.....	0	2.....	0
42.....	0	4.....	0	3.....	0	3.....	0
43.....	0	011 00		4.....	0	4.....	0
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45.....	0	2.....	5	6.....	0	6.....	0
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8.....	0	14.....	3	18.....	0	18.....	0
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13.....	0	19.....	5	23.....	0	23.....	0
14.....	0	20.....	5	24.....	0	24.....	0
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STRUCTURE REPAIR

GENERAL INFORMATION

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-
1. The TPDRs listed below have been incorporated in this issue.

IDENTIFICATION NUMBER/ QA SEQUENCE NUMBER	LOCATION
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STRUCTURE REPAIR

GENERAL INFORMATION

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This WP supersedes WP001 01, dated 1 June 1996.

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004 09	Substitution Fasteners	004 38	Bearing Removal and Installation Tool Set, Part No. 74D110166-1001
004 10	Cold Working Fastener Holes	004 39	SK350-00192 Adhesive Comb
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		019 00	Wet Layup Patch Fabrication

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Reference Material

None

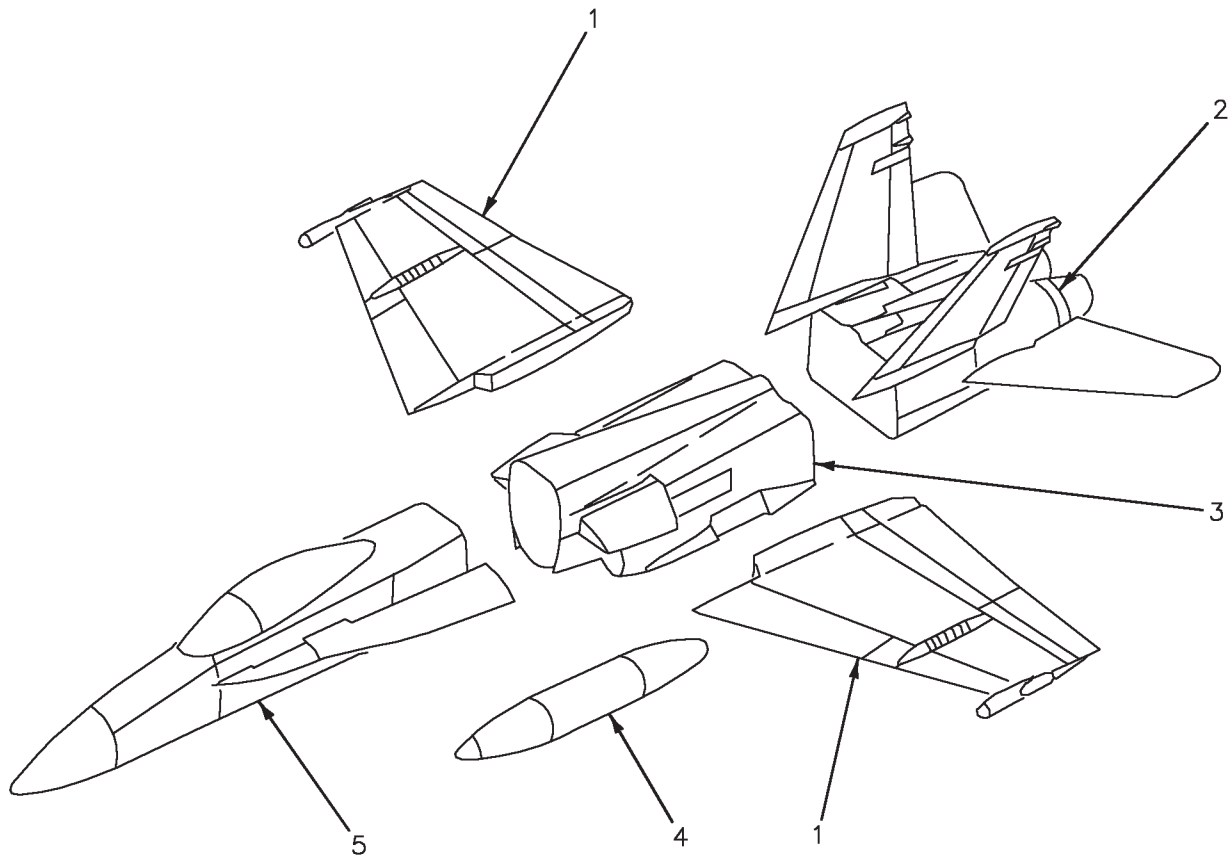
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Record of Applicable Technical Directives

None

- 1. INTRODUCTION.** See figure 1.
2. This work package shows location of each aircraft structure group, and identifies with structure repair series manuals (WP002 00).



ITEM	STRUCTURE GROUP	VOLUME
1	WING	A1-F18AC-SRM-210, F/A-18A, F/A-18B A1-F18AE-SRM-600, F/A-18C, F/A-18D
2	AFT FUSELAGE	A1-F18AC-SRM-240, F/A-18A, F/A-18B A1-F18AE-SRM-750, F/A-18C, F/A-18D
3	CENTER FUSELAGE	A1-F18AC-SRM-230, F/A-18A, F/A-18B A1-F18AE-SRM-700, F/A-18C, F/A-18D
4	EXTERNAL FUEL TANK	A1-F18AC-SRM-210, F/A-18A, F/A-18B A1-F18AE-SRM-600, F/A-18C, F/A-18D
5	FORWARD FUSELAGE	A1-F18AC-SRM-220, F/A-18A, F/A-18B A1-F18AE-SRM-650, F/A-18C, F/A-18D

Figure 1. Aircraft Structure Index

INTRODUCTION

ORGANIZATIONAL, INTERMEDIATE, AND DEPOT MAINTENANCE

GENERAL INFORMATION

This WP supersedes WP002 00, dated 1 August 1997.

1. PURPOSE.

2. This manual provides general information for organizational, intermediate, and depot levels of maintenance. Types of information to be included, but not limited to, are: aircraft description, shop practices, contour data, repair materials, and in-service tolerances.

3. REQUISITION AND AUTOMATIC DISTRIBUTION OF NAVAIR TECHNICAL MANUALS.

4. Procedures to be used by Naval activities and other Department of Defense activities requiring NAVAIR technical manuals are defined in NAVAIR 00-25-100 and NAVAIRINST 5605.5.4A.

5. To automatically receive future changes and revisions to NAVAIR technical manuals, an activity must be established on the Automatic Distribution Requirements List (ADRL) maintained by the Naval Air Technical Data and Engineering Service Command (NATEC). To become established on the ADRL, notify your activity central technical publications librarian. If your activity does not have a library, you may establish your automatic distribution by contacting the Commanding Officer, NATEC, Attn: Distribution, NAS North Island, Bldg. 90, P.O. Box 357031, San Diego CA 92135-7031. Annual reconfirmation of these requirements is necessary to remain on automatic distribution. Please use your NATEC assigned account number whenever referring to automatic distribution requirements.

6. If additional or replacement copies of this manual are required with no attendant changes in the ADRL, they may be ordered by submitting a MILSTRIP requisition in accordance with NAVSUP 485 to Routing Identifier Code "NFZ". MILSTRIP requisitions can be submitted through your supply office, Navy message, or SALTS to

DAAS (Defense Automated Address System), or through the DAAS or NAVSUP web sites. For assistance with a MILSTRIP requisition, contact the Naval Inventory Control Point (NAVICP) Publications and Forms Customer Service at DSN 442-2626 or (215) 697-2626, Monday through Friday, 0700 to 1600 Eastern Time.

7. MANUAL ISSUE DATE.

8. The date on the title page is the copy freeze date. No additions, deletions, or changes are made after the manual issue date except last minute safety of flight or required maintenance changes. Data collected after the manual issue date will be included in later changes or revisions of the manual.

9. AIRCRAFT DESCRIPTION.

10. For general description, principle dimensions, station locations, types of construction, and new materials used on the aircraft (WP003 00).

11. EFFECTIVITIES.

12. Effectivity notes on manual title pages, work package title pages, and within a work package indicate the aircraft or software program to which the data applies. If no effectivity note appears on the work package title page, the work package has the same effectivity as shown on the manual title page. The effectivity notes may use:

NOTE

Aircraft with model designator F/A-18B/D are the same type and model as TF/A-18A.

- a. Type, model, and series
- b. Bureau number (tail number)

c. Combination of type, model, series, and bureau numbers

e. Technical directive number

d. Part number or serial number

The table below shows examples of effectivity notes and their meanings:

Effectivity Note Examples

Effectivity Note	Definition
161362 AND UP	Applicable to all F/A-18A, F/A-18B, F/A-18C and F/A-18D for bureau numbers listed.
F/A-18A, F/A-18B	Applicable to all F/A-18A and F/A-18B.
F/A-18C, F/A-18D	Applicable to all F/A-18C and F/A-18D.
F/A-18A	Applicable to all F/A-18A, but not F/A-18B, F/A-18C and F/A-18D.
F/A-18B	Applicable to all F/A-18B, but not F/A-18A, F/A-18C, and F/A-18D.
F/A-18C	Applicable to all F/A-18C, but not F/A-18A, F/A-18B, and F/A-18D.
F/A-18D	Applicable to all F/A-18D, but not F/A-18A, F/A-18B, and F/A-18C.
F/A-18A, F/A-18C	Applicable to all F/A-18A and F/A-18C, but not to F/A-18B and F/A-18D.
F/A-18B, F/A-18D	Applicable to all F/A-18B and F/A-18D, but not to F/A-18A and F/A-18C.
F/A-18A 161353, 161359 THRU 161364	Only applicable to some bureau numbers of F/A-18A. Not applicable to any F/A-18B, even if a F/A-18B bureau number is within the numbers listed.
F/A-18C 163427, 163449 THRU 163456	Only applicable to some bureau numbers of F/A-18C. Not applicable to any F/A-18D, even if a F/A-18D bureau number is within the numbers listed.
F/A-18B 161354 AND UP	Only applicable to some bureau numbers of F/A-18B. Not applicable to any F/A-18A, even if an F/A-18A bureau number is within the numbers listed.
F/A-18D 163434 AND UP	Only applicable to some bureau numbers of F/A-18D. Not applicable to any F/A-18C, even if a F/A-18C bureau number is within the numbers listed.
161353 THRU 161356 BEFORE F/A-18 AFC 772	Applicable to F/A-18A and F/A-18B for bureau numbers listed, before modification by technical directive.
161357 AND UP; ALSO 161353 THRU 161356 AFTER F/A-18 AFC 772; AND F/A-18C AND F/A-18D	Applicable to aircraft modified during production; also applicable when affected aircraft have been modified by technical directive.

Effectivity Note Examples (Continued)

Effectivity Note	Definition
P/N 74A210001-1001, 74A210001-1003, AND 74A210001-1005	Applicable to assemblies which are interchangeable between aircraft.
Outer Wing Assembly Serial Number A13-0022	Applicable to assemblies which are interchangeable between aircraft, but configurations can not be identified by part number.

13. TECHNICAL DIRECTIVES.

14. Technical directives are documents which provide instructions to incorporate and record retrofit configuration modifications or inspection instructions to delivered aircraft, or aircraft components.

15. AIRFRAME CHANGE (AFC) AND AIRBORNE SOFTWARE CHANGE (ASC). Technical directives which change configuration of aircraft structure or equipment installation, i.e. AFC, will list aircraft bureau numbers in effectivity notes and show before and after the AFC. Technical directives which change configuration of operational flight programs (OFP), i.e. ASC, will list the OFP CONFIG/IDENT NUMBER in effectivity notes and show the latest two authorized OFP programs. See AFC and ASC effectivity examples in Effectivity Note Example Table.

16. AIRCRAFT COMPONENT CHANGES.

Technical directives which change configuration of aircraft components are listed below:

AAC	Aviation Armament Change for armament equipment
ACC	Aircrew System Change for aircrew survival equipment
AFC	Airframe Change for aircraft structure and equipment
ASC	Airborne Software Change for operational flight programs
AVC	Avionics Change for airborne electronic equipment, including wiring changes
AYC	Accessory Change for mechanical system
PPC	Power Plant Change for engines

17. RECORD OF APPLICABLE TECHNICAL DIRECTIVES.

18. The technical directives affecting this manual are listed in the Record of Applicable Technical Directives of each affected work package. Because an ASC directs all aircraft be modified within 30 days, ASC's are not listed. When all affected aircraft are modified, the before configuration is removed from the manual, and the technical directive entry is removed from the Record of Applicable Technical Directives.

19. HOW TO USE THE MANUAL.

20. Text and illustrations contained in this manual are in work package format. These work packages are complete sets of data or procedures arranged in a logical sequence supplying instructions, references, and material/equipments requirements. Work package types contained in this manual are listed below:

a. Numerical Index of Effective Work Packages/Pages. This index (A page) provides the user with the current status of the publication.

b. List of Technical Publication Deficiency Reports Incorporated. The TPDR work package lists the TPDRs that are incorporated in the current issue of the manual

c. Alphabetical Index Work Package. This work package contains an alphabetical listing, by title, of each work package contained within the manual. This work package is numbered 001 00.

d. Work Package Index. This work package contains a listing of all work packages, with their titles, assigned to the manual. This work package is numbered 001 01.

e. Aircraft Structure Index Work Package. This work package contains an illustration indexing

location of each structure group. It contains a table listing the structure repair volume containing each structure group. This work package is numbered 001 02.

f. Introduction Work Package. This work package contains introductory information for the maintenance persons use. This work package is numbered 002 00.

21. DAMAGE EVALUATION.

22. When evaluating damage to structural areas for scratches, dents, nicks, and gouges in specific structure repair series manuals A1-F18AC-SRM-210 thru -240 and A1-F18AE-SRM-600 thru -750, interpret negligible damage limits and repairable damage limits after blending tables as below:

a. Damage less than limit in negligible limit table; no action required except for corrosion prevention/treatment as required per specific procedures work package.

b. Damage greater than limit in negligible limit table; blend out damage per specific procedure work package.

c. After blending, depth of blending required to remove damage exceeds limits of repairable damage after blending table; engineering disposition required or repair per specific procedures work package.

23. WARNINGS, CAUTIONS, AND NOTES.

24. Items of special importance and critical information are identified in warnings, cautions, and notes. Warnings and cautions appear immediately before the step to which they apply. Notes may appear before or after the affected step.

WARNING

Warnings describe conditions or procedures that could result in injury or death if correct procedures are not followed.

CAUTION

Cautions describe conditions or procedures that could result in damage to or destruction of equipment if correct procedures are not followed.

NOTE

Notes describe or clarify conditions or procedures.

25. SAFETY PRECAUTIONS

26. Safety precautions applicable to structure repair are contained in NAVAIR 01-1A-1 and when applicable in specific and typical procedure work packages within the structure repair volume series.

27. TECHNICAL PUBLICATIONS DEFICIENCY REPORT (TPDR).

28. The TPDR (OPNAV FORM 4790/66) is the form for reporting errors and suspected omissions in the technical manuals. Reporting procedures are in OPNAVINST 4790.2 SERIES.

29. QUALITY ASSURANCE PROCEDURES.

30. Procedures or parts of procedures which require quality assurance inspection are identified by the letters (QA) after the applicable steps. When (QA) is assigned to a step or a heading which is immediately followed by substeps, the inspection requirement is applicable to all substeps.

31. When doing maintenance in any area, a visual inspection of the area will be made for cracks, corrosion and security of component installation before securing the area for flight.

32. STRUCTURE REPAIR TERMS.

33. This list contains definitions for commonly used structural repair methods, letter symbols, and repair terms of a general nature which may be applicable.

a. ION VAPOR DEPOSITION, ALUMINUM (IVD) - Application of coating with high purity aluminum on ferrous and nonferrous metals for corrosion prevention or protective finish.

b. NEGLIGIBLE DAMAGE - Damage or distortion which can be allowed to exist as is.

c. REPAIRABLE DAMAGE - Damage which can be permanently corrected by reworking damaged structure or components with no adverse effects upon structural integrity, flight characteristics, or safety-of-aircraft. This includes minor replacement of parts or correction by simple procedure such as; removing dents, stop-drilling cracks, or temporary patching without putting restrictions on flight.

d. MAJOR DAMAGE - Damage which requires replacement of structural components and major assemblies or engineering evaluation to determine if repair is practical.

NOTE

Temporary repairs are restricted to extraordinary or unusual circumstances, example; crash damage or battle damage occurring in an environment not suitable, or area not easily accessible, to required personnel or equipment.

e. TEMPORARY REPAIR - Temporary repair is one which may be made to allow aircraft to be flown until permanent repair can be made. Temporary repair normally restores full load carrying capabilities to required member but may be lacking from standpoint of interchangeability of parts, aerodynamically, or with respect to fatigue life. Normally temporary repair will be removed and permanent repair installed at earliest practical time. Instructions for temporary repairs include information on flight restrictions which must be observed until permanent repairs have been completed. Temporary repairs are as simple and practical as possible. Repair procedures use the most basic tools practical. Materials requiring unsophisticated fabrication methods are used.

f. ONE-TIME FLIGHT REPAIR - One-time flight repair is temporary repair made to restore limited load-carrying requirements to allow an aircraft to be flown to a repair station for permanent repairs. Instructions for one-time flight

repair include all information on flight restrictions which must be observed during ferry flight.

g. PERMANENT REPAIR - Permanent repair equals or exceeds strength of original structure or component with no adverse effects on structural integrity, fatigue life, safety, or flying characteristics of aircraft.

h. CRITICAL AREA REPAIR - Critical area repairs are specific repairs in areas which are highly stressed, fatigue critical, or corrosion prone in normal use. Damage in these areas effect safety of aircraft. Information and instructions for critical area repairs include flight restrictions which must be observed until permanent repairs have been completed.

i. ALTERNATE REPAIR - Alternate repairs are provided when practical. When repair involves use of an extrusion, an alternate using sheet, bar, or tubing is provided. When new types of material are required, an alternate using more common generally available material is provided.

j. TYPICAL REPAIR - Typical repair is repair which is applicable to more than one structure group or component. Typical repair procedures are referenced from structure repair series manuals.

k. CLASS A SEALANT - Suitable for brush application.

l. CLASS B SEALANT - Suitable for spatula or injection gun application.

m. FAY SEAL - Seal sandwiched between mating surfaces of two parts or assemblies.

n. BUTT JOINT SEAL - Fills gap between components.

o. FASTENER SEALING - Applying sealing compound directly to fasteners, fastener hole, or countersink during installation.

p. FILLET SEAL - Continuous bead of sealing compound along seam or joint and worked in place with fairing tool.

q. TACK-FREE - Sealing compound is soft, but will not stick to hand.

r. SET-TO-TOUCH - Sealant will not transfer to finger when touched. Sealant can be primed in this condition.

s. LEG - Longer part of formed angle.

t. FLANGE - Short part of formed angle. If each is same length, each is known as leg.

u. BEND TANGENT LINE (BTL) - Line at which metal starts to bend.

v. BEND ALLOWANCE (BA) - Amount of material consumed in making a bend.

w. RADIUS (RAD) - Radius of bend, is always inside of metal being formed.

x. BEND LINE (BL) - Guideline used in aligning material when put into forming tool.

y. CHEMICAL MILLED (CHEM-MILLED) - Manufacturing process where metal is uniformly removed from part or from selected areas by chemical etching of exposed surfaces. Unexposed surfaces, those which are not to be milled, are protected by rubberized mask materials.

z. LETTER SYMBOL X - Symbol X, similar to multiplication symbol, is used to indicate dimensions of part; thickness, width and length. Example; a part 5 inches thick, 10 inches wide, and 12 inches long is shown as 5 X 10 X 12.

aa. ROUGHNESS HEIGHT RATING (RHR) - Surfaces roughness identifies with machine finish of part. RHR is average of height variations, measured in millionths, 0.000001, of an inch. Actual roughness height, maximum peak to maximum valley, on surface will be approximately three times measured average. Part function should determine part finish. Example; steel structural parts have RHR of 250 and aluminum and titanium structural parts have RHR of 125. Smaller the RHR value smoother the part finish. Example, surface of shaft to be run in teflon lined bushing has RHR value of 8.

ab. EXOTHERM - Release of heat, as used in repair procedures during cure cycle of sealants and adhesives.

ac. HOMOGENEOUS - Material of uniform composition throughout.

ad. BATCH (LOT) - Quantity of material formed during same process and having identical characteristics.

ae. CURE - To change properties of thermosetting resins making them unchangeable by chemical reaction.

af. YOKE (PROBE) - Hand held electromagnet which supplies longitudinal magnetic field between legs when placed on part and energized.

ag. TRUE CONTINUOUS METHOD - Magnetic particle inspection method, primarily used when inspecting with yoke (probe). Inspection material is applied to part and inspection is done while magnetizing current is on.

ah. ADHESIVE - Two part compound made up of accelerator and base used to make repairs.

ai. ADHESIVE FILM - Sheet type adhesive, heat activated.

aj. ARAMID LAMINATE - Epoxy woven fabric or polyester woven fabric is available in unidirectional fiber or woven fabrics. Used for high performance composite structure both monolithic and sandwich constructions.

ak. AUTOCLAVE - Pressurized oven using heat and pressure.

al. B-STAGE - Intermediate stage in reaction of thermosetting resin in which material softens when heated and swells in contact with certain solvents but does not entirely fuse or dissolve. Materials are usually precured to this stage to aid handling and processing before final cure.

am. BLEEDER CLOTH - Glass cloth used to absorb excess resin during cure.

an. BREATHER CLOTH - Two or more layers of dry glass cloth, placed on top of resin barrier and extended out to cover vacuum and static ports.

ao. COMPOSITE - Materials consisting of high strength filaments encased in a matrix, normally epoxy.

ap. COMPOSITE BONDING - Layup and cure of laminate composite structures and joining of composite and metal structures by use of heat activated adhesives.

aq. DELAMINATION - Separation between plies of laminated part.

ar. UNBOND - Separation of skin to core, skin to skin, or skin to closure bond.

as. GLASS CLOTH - Conventionally woven glass fiber material.

at. GRAPHITE EPOXY - Composite made of graphite fibers and epoxy matrix autoclave cured.

au. HONEYCOMB - Structure of hexagonal thin walled cells constructed of aluminum.

av. LAMINATE - Made by bonding together two or more plies of material.

aw. LAY UP - Process of fabrication involving placement of successive plies of materials.

ax. N.D.I. - Nondestructive inspection.

ay. PEEL PLY - Layer of strippable cloth laid up on surface of composite part and removed just before adhesive bonding or painting of surface.

az. RELEASE CLOTH - Teflon impregnated glass cloth, used to prevent production parts from becoming bonded to tools or bleeder cloth during bonding operations.

ba. SCRIM - Reinforcing fabric (glass cloth) used in processing of tape or other b-stage material to aid handling.

bb. VACUUM LINE - Tube type structure extending from inside vacuum envelope to an outside vacuum source.

bc. COLD BONDING - Bonding at room temperature.

bd. RESIN - Organic material.

be. BOND SEPARATION - Separation of core to structure bond.

bf. STEP AREA UNBOND - Separation of bond between composite and metallic portions of bonded skin assemblies.

bg. METAL TO METAL UNBOND - Separation of bond between two metal pieces.

bh. ALPHA CASE - Hard brittle layer of surface oxidation on titanium. This condition will appear as dull non-reflective oxide. Bright colors ranging from yellow through red to dark blue are thinner layers of oxide than alpha case and are good.

bi. MOLD LINE - Outer skin surface of aircraft.

bj. ACCELERATOR - Component added to base compound to get cured seal.

bk. ACTIVATED SEALANT - Sealant that has had accelerator combined with base compound.

bl. BASE COMPOUND - Compound that forms the seal.

bm. COUPLING AGENT - Promotes bonding of sealant to surfaces.

bn. DAM GAP SEAL - Filling of structural gaps and forming of channel groove with class B sealant.

bo. INJECTION GUN - Pneumatic or manually operated device used to discharge sealant.

bp. POT LIFE - Allowed time to apply activated sealants.

bq. SEALANT - Mixture of base compound and accelerator that cures to firm material.

br. FRACTURE CRITICAL ITEMS - Individual structural parts identified by engineering as having critical load carrying capabilities. Failure of any one item would cause safety-of-flight condition.

bs. MAINTENANCE CRITICAL ITEMS - Individual structural parts identified by engineering as having critical maintenance impact if replacement of part is required. Failure of any one item would not cause safety-of-flight condition but could have significant operational, maintenance, or cost impact.

34. INSTALLATION PROCEDURE SYMBOLS.

35. Symbols used in skin, structure, and fastener indexes, repair illustrations, and replacement procedure illustrations are shown in figure 1.

36. DIMENSIONS.

37. Unless noted in text or on illustrations, all dimensions in structure repair series manuals are in inches.

38. STRUCTURE REPAIR SERIES MANUALS.

39. Structure repair series manuals provide personnel at all maintenance levels with

instructions for repair of structural damage to aircraft. Manuals are numbered and contain below listed information:

a. A1-F18AC-SRM-200, Structure Repair, General Information, F/A-18A/B/C/D.

Provides general information for organizational intermediate, and depot levels of maintenance. Types of information to be included, but not limited to, are: aircraft description, shop practices, contour data, repair materials, and in service tolerances.

b. Wing, A1-F18AC-SRM-210,
F/A-18A, F/A-18B.
Wing, A1-F18AE-SRM-600,
F/A-18C F/A-18D.
Forward Fuselage, A1-F18AC-SRM-220,
F/A-18A, F/A-18B.
Forward Fuselage, A1-F18AE-SRM-650,
F/A-18C, F/A-18D.
Center Fuselage, A1-F18AC-SRM-230,
F/A-18A, F/A-18B
Center Fuselage, A1-F18AE-SRM-700,
F/A-18C, F/A-18D
Aft Fuselage, A1-F18AC-SRM-240,
F/A-18A, F/A-18B.
Aft Fuselage, A1-F18AE-SRM-750,
F/A-18C, F/A-18D.

Provides damage evaluation, repair, and replacement information for structural items at organizational, intermediate, and depot levels of maintenance.

c. A1-F18AC-SRM-250, Typical Repair, F/A-18A/B/C/D.

Provides typical repair procedures for organizational, intermediate, and depot levels of maintenance. Level of maintenance a repair can be made is determined in structure series manual

containing the damaged assembly. Structure series manuals will reference this manual for repair.

d. A1-F18AC-SRM-300, Nondestructive Inspection, F/A-18A/B/C/D.

Provides nondestructive inspection procedures for organizational, intermediate, and depot levels of maintenance.

e. A1-F18AC-SRM-400 series manuals, Structure, Illustrated Parts Breakdown (IPB), F/A-18A/B/C/D.

Provides parts list illustrations for requisition, authority for use, and identification of parts used for structural replacement purposes in A1-F18AC-SRM-210 thru -240 and A1-F18AE-SRM-600 thru -750 series manuals. The IPB is divided into five manuals as listed below:

(1) A1-F18AC-SRM-410, Structure, Illustrated Parts Breakdown -Wing.

(2) A1-F18AC-SRM-420, Structure, Illustrated Parts Breakdown - forward Fuselage.

(3) A1-F18AC-SRM-430, Structure, Illustrated Parts Breakdown - Center Fuselage.

(4) A1-F18AC-SRM-440, Structure, Illustrated Parts Breakdown - Aft Fuselage.

(5) A1-F18AC-SRM-450, Structure, Illustrated Parts Breakdown - Parts List Index.

f. A1-F18AC-SRM-500, Aircraft Corrosion Control, F/A-18A/B/C/D.

Provides corrosion control procedures for organizational, intermediate, and depot levels of maintenance.

INSTALLATION PROCEDURE SYMBOLS





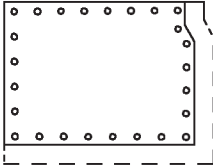


	A. INDICATES EXISTING HOLES WHICH DO NOT REQUIRE DRILLING OR REAMING.
	B. INDICATES POSITION OF HOLE WHICH MUST BE DRILLED.
	C. INDICATES POSITION OF HOLE WHICH HAS BEEN PILOT DRILLED BUT WHICH MUST BE ENLARGED TO CORRECT DIAMETER.
	D. WITHIN SHADED AREA, ALL HOLES ARE SAME DIAMETER AND ALL ATTACHING HARDWARE IS SAME TYPE AND SIZE.
	E. THE DASHED LINE INDICATES EDGE OF PART WHICH MUST BE TRIMMED FOR INSTALLATION.
	F. STEP IN INSTALLATION PROCEDURE REQUIRING REFERENCE TO FIELD OF DRAWING.
	G. PART HAS BEEN CUT AT THIS SECTION TO SHOW INTERIOR VIEW. (ALSO USED ON REPAIR INDEX AND PROCEDURE).

Figure 1. Installation Procedure Symbols

ORGANIZATIONAL MAINTENANCE

STRUCTURE REPAIR

AIRCRAFT DESCRIPTION

Reference Material

Aircraft Corrosion Control.....	A1-F18AC-SRM-500
Form in Place Sealing.....	WP010 00
Line Maintenance Manual.....	A1-F18AC-LMM-010

Alphabetical Index

Subject	Page No.
Description	1
Covers and Doors	3
General Description	1
Principal Dimensions.....	2
Station Locations	2
Types of Construction	2
High Temperature Areas	5
New Materials.....	3

Record of Applicable Technical Directives

None

1. DESCRIPTION.

2. The F/A-18A was planned with maintainability, reliability, and the maintenance person in mind. The aircraft have variable camber mid wing with leading edge extensions, two vertical stabilizers angled 20° from vertical, hydraulically controlled rudders and stabilators, hydraulically actuated leading and trailing edge flaps and ailerons, and tricycle landing gear.

3. GENERAL DESCRIPTION.

a. Forward Fuselage. The forward fuselage starts with the nose radome tip at FS 60.50 and extends to FS 383.0 at forward center fuselage splice. Arrangement of this section includes; leading edge extension support, nose landing gear support, cockpit, radar system support, 20 mm gun support, avionics bays, number one fuselage fuel cell, and

refueling probe system. Materials used are; aluminum, titanium, steel, fiberglass, plexiglas, and graphite epoxy composite.

b. Inner and Outer Wing:

(1) The inner wing is attached to fuselage at three primary and one secondary points. The inner wing torque box forms an integral fuel tank. Arrangement of this section includes; external store stations, wingfold system, hinge support for flaps, aileron and shroud, trailing edge flap and shroud, leading edge extension and support. Materials used are; aluminum, titanium, steel, graphite epoxy composite, and graphite epoxy composite honeycomb sandwich.

(2) The outer wing connects inner wing at the wing fold. This wing is made up of torque box,

missile launcher, outboard leading edge flap, aileron, and aileron shroud.

c. Center Fuselage. The center fuselage is two sections; forward center extends from FS 383.00 to FS 453.0 and aft center extends from FS453.0 to FS 557.50. Arrangement of this section includes; engine air inlet supports, number two, three, and four fuel cells, and main landing gear. Materials used are aluminum, titanium, steel, graphite epoxy composite, graphite epoxy composite honeycomb sandwich, and Aramid laminate woven cloth.

d. Aft Fuselage. The aft fuselage boundary is the splice at FS 557.5 and aft end of exhaust nozzle fairing at FS 687.931. Arrangement of this section includes, structural interface with vertical fins, speed brake, arresting hook support, engine mounts and engine bay doors, horizontal tail spindle, horizontal tail actuator support, controls mixer mechanism bay, fuel vent tank, and engine nozzle fairing. Materials used are; aluminum, titanium, steel, graphite epoxy composite, and graphite epoxy composite honeycomb sandwich.

e. Empennage. The empennage is made up of horizontal stabilator, vertical stabilizers, and rudders. Materials used are; aluminum, titanium, graphite epoxy composite, graphite epoxy composite honeycomb sandwich, and fiberglass.

f. Landing Gear. The tricycle landing gear, launch bar, and arresting hook are made of aluminum, titanium, and steel. Nose and main landing gear doors and nose drag brace fairing are made of aluminum, titanium, steel, graphite epoxy composite and graphite epoxy composite honeycomb sandwich.

4. Types of Construction. Aircraft structure, with resistance to corrosion a major consideration, is best described as conventional, multi-stiffened, semi-monocoque. Several airframe arrangements that contribute to structural efficiency are listed below:

a. Use of advanced materials, example; titanium, high strength steels, and fibrous composites combined with structure arrangement, provide maximum weight/strength ratios.

b. The continuous center line keel structure and lower longerons.

(1) Deep beam, trunnion mounted nose landing gear with aft-oriented drag brace.

(2) The arresting hook is attached to dual lower longerons in aft fuselage.

c. A bolt-on wing attachment is used to simplify assembly and take advantage of increased root depth.

d. The multi-cell primary wing box and semi-monocoque, multi-cell fuselage construction provide structural strength.

e. The main landing gear is trunnion attached to a fuselage bulkhead and retracts aft and inboard.

f. Gun mounting in nose barrel section allows continuous primary structure.

g. Equipment has been arranged for easy access without structure hindrance.

h. Composite honeycomb sandwich construction, graphite epoxy composite, and fiberglass/Aramid laminate are used in below listed areas:

- (1) Nose radome
- (2) Empennage
- (3) Inner and outer wings
- (4) Control surfaces
- (5) Skins, access covers/doors
- (6) Speed brake

5. Principal Dimensions. See figure 1.

6. Station Locations. For major aircraft coordinates, see figures 2 through 6.

a. Station locations are listed below:

- (1) Buttock lines (BL) are X stations.
- (2) Fuselage stations (FS) are Y stations.
- (3) Water lines (WL) are Z stations.

b. Stations locate bulkheads, ribs, spars, or other structure. Numbers given to stations or reference lines represent distance in inches from a selected point.

c. Buttock lines, X stations, indicate vertical lines parallel to longitudinal center line of aircraft.

Buttock line zero, BL 0.000, indicates center line of aircraft. Left and right buttock lines are measured from this line. Right buttock lines are shown with a - sign before it, example; X - 8.500.

(1) Wing buttock lines, XW stations, are a continuation of fuselage buttock lines, see figure 4.

d. Fuselage stations, Y stations, are longitudinal positions of vertical planes perpendicular to plane of symmetry, see figures 2, 3, 5, and 6. Forward end of nose radome is fuselage station Y60.500 and lines are measured in inches aft of this point.

(1) A canted fuselage station is CY, see figure 3.

e. Horizontal stabilator stations XH stations, see figure 6, are planes vertical to cord plane of horizontal stabilator. Stabilator stations are parallel to fuselage buttock lines.

(1) YH stations are longitudinal positions of vertical planes perpendicular to plane of symmetry, see figure 6.

f. Water lines (WL), Z stations, indicate horizontal planes parallel to an arbitrary reference plane.

g. External fuel tank stations, see figure 7, are as below:

(1) Buttock lines (XT)

(2) Tank stations (TS)

(3) Water lines (ZT)

7. NEW MATERIALS. New materials are used in aircraft to limit weight, decrease effect of corrosion attack, and to increase strength. Some new materials are listed below.

a. Composites:

(1) Graphite epoxy cloth. Epoxy resin impregnated cloth, moderate temperature -65° F to 250° F, high strength woven graphite fabric. Used for high performance composite structure both monolithic and sandwich, where non-planar parts or substructures requiring forming are involved.

(2) Graphite epoxy tape and broad goods - MMS-549, Types I and II. Epoxy resin impregnated, moderate temperature -65° F to 250° F,

high strength unidirectional graphite fiber tape and broad goods. Used for high performance composite structure both monolithic and sandwich. Use of Type II is recommended to minimize fabrication cost.

(3) Aramid laminate - (MMS-525, Type I and II). Epoxy woven fabric or polyester woven fabric is available in unidirectional fibers or woven fabrics. Used for high performance composite structures both monolithic and sandwich constructions. Temperature range is primarily dependent upon impregnating resin and secondly upon temperature limit of fiber. Recommended for reinforced plastic ducting, fairings, and similar parts and effective means of weight reduction, compared to fiberglass reinforcement. There are two tapes with no specification number - unidirectional tape and polyester woven tape, these meet the above uses.

b. Metal:

(1) Chrome nickel steel -300M series. Ultra high strength, basic 18-8 chrome - nickel steel, heat treated 280,000 to 300,000 psi. Has good stress corrosion resistance, good natural corrosion resistance, good natural corrosion resistance when used with coatings, and can be ion vapor deposition (aluminum) (IVD) coated, VAC cadmium coated, or sealed in cavity or low access areas. HP9, 4-30/40, and AF1410 steels.

8. COVERS AND DOORS. Covers and doors are made of fiberglass, titanium, graphite epoxy, and aluminum. All function to provide; access to internal structure or components, and aerodynamic mold line surfaces.

a. Access covers:

(1) Fiberglass access covers. Access covers are fabricated from fiberglass epoxy laminates and fiberglass epoxy honeycomb of various sizes and shapes. The inner wings have fiberglass covers allowing internal access to wing fuel cell for component replacement. Fiberglass epoxy laminated covers located on center fuselage provide access to primary heat exchanger and on vertical stabilizers provide access to fuel vents. Some covers are drilled and trimmed to specifications and others must be trimmed to meet gap tolerances.

(2) Titanium access covers. Titanium access covers contain an aluminum honeycomb core sandwiched between titanium skins. Some require close tolerance and for that reason are chemical milled during fabrication. Chemical milled covers are used in leading edge flap system and are referred to as aerodynamic seals. These covers provide access to flap torque tubes, power hinges, and other hardware items. Chemical milled covers are used for access to left and right crossover tunnel areas, vertical stabilizers, and bottom forward fuselage.

(3) Graphite epoxy honeycomb sandwich access covers. Graphite epoxy honeycomb sandwich access covers are located primarily on fuselage top, providing access to fuel system components and tanks. Wing access covers provide top wing access to fuel dump mechanism and aileron switching valves. Graphite epoxy covers use form in place and extruded seals. Attachment to aircraft structure is by hi-torque recess tension head fasteners. Covers are classified interchangeable and replaceable. Interchangeable covers require application of attachment fasteners for installation and replaceable covers require attachment fasteners and trimming to meet gap requirements.

(4) Aluminum honeycomb sandwich access covers. Aluminum honeycomb sandwich access covers are located on top of each wing, aft, and upper aft fuselage. These covers incorporate form in place seals and are attached to aircraft structure using hi-torque recess tension head fasteners. Covers allow access to aileron servocylinder, fuel vent lines, and tip decoder.

(5) Aluminum access covers. Aluminum access covers are generally fabricated from 7075-T6, alclad. Some covers are chemically milled. Access covers vary in size depending on component(s) access requirements. Covers are secured with hi-torque screws or quick-release fasteners.

b. Access doors:

(1) Graphite epoxy honeycomb sandwich access doors. Graphite epoxy honeycomb sandwich access doors are located on the forward fuselage and include avionics and gun loader doors. These doors use piano hinges, form in place seals, support braces, and rotary latches. Piano hinge is electrically bonded to door and airframe. Avionics access doors are located to allow ease of installation and removal of installed equipment.

(2) Aluminum access doors. Aluminum access doors are fabricated from 7075-T6, T73, T76, T7351, 2024-T72, and T81 alclad. Doors are processed by pressing, machining, chemical milling, or forming. Doors vary in size depending on component(s) to which they provide access. Doors are hinged and secured with latches or quick-release turnlock fasteners.

(3) Titanium access doors. Titanium doors are chemical milled, piano hinged, and secured with high strength, quick-release, structural fasteners. Doors are used on extreme aft section for engine exhaust nozzle access.

(4) Aluminum access seals. Aluminum seals are fabricated primarily from 7075-T6 and T76 alclad using chemical milling process. Seals vary in size depending on component(s) access requirements. Seals are secured using hi-torque screws.

c. Form in place seals (A1-F18AC-SRM-500, WP010 00). Form in place seals are installed around removable covers and doors and around all permanent skins on exterior mold line surfaces. Types of form in place seals are; butt gap form in place, form in place on doors, form in place on structure.

(1) Butt gap form in place seals. Seals around edges of all permanent skins on exterior mold line surfaces. These seals prevent moisture entry, prevent dissimilar metal contact, and provide aerodynamic exterior mold line surfaces.

(2) Form in place seal on door. This seal is formed on mating surface of door to prevent moisture entry and dissimilar metal contact.

(3) Form in place seal on structure. This seal is formed on the door mating surface of structure to prevent moisture entry and dissimilar metal contact.

d. Electromagnetic Interference (EMI) seals (A1-F18AC-LMM-010) Inspection of doors for damage. Covers and doors have either an electrical bonding strip or an EMI gasket.

(1) The bonding strip has projecting spring fingers which contact aircraft structure when door is closed.

(2) The EMI gasket is a rubber extrusion enclosed in wire mesh.

9. **HIGH TEMPERATURE AREAS.** See figure 8. High temperature areas of aircraft are areas in which temperature in excess of 225° F will exist. To use correct materials, fasteners, adhesives, and processes when making repairs, temperature of area being repaired should be considered. When

materials, fasteners, adhesives, or processes are specified in a repair in other manuals, it shall take precedence over temperature considerations on this figure. If repair to be made is in more than one high temperature area, use higher temperature to select materials, fasteners, adhesives, and processes.

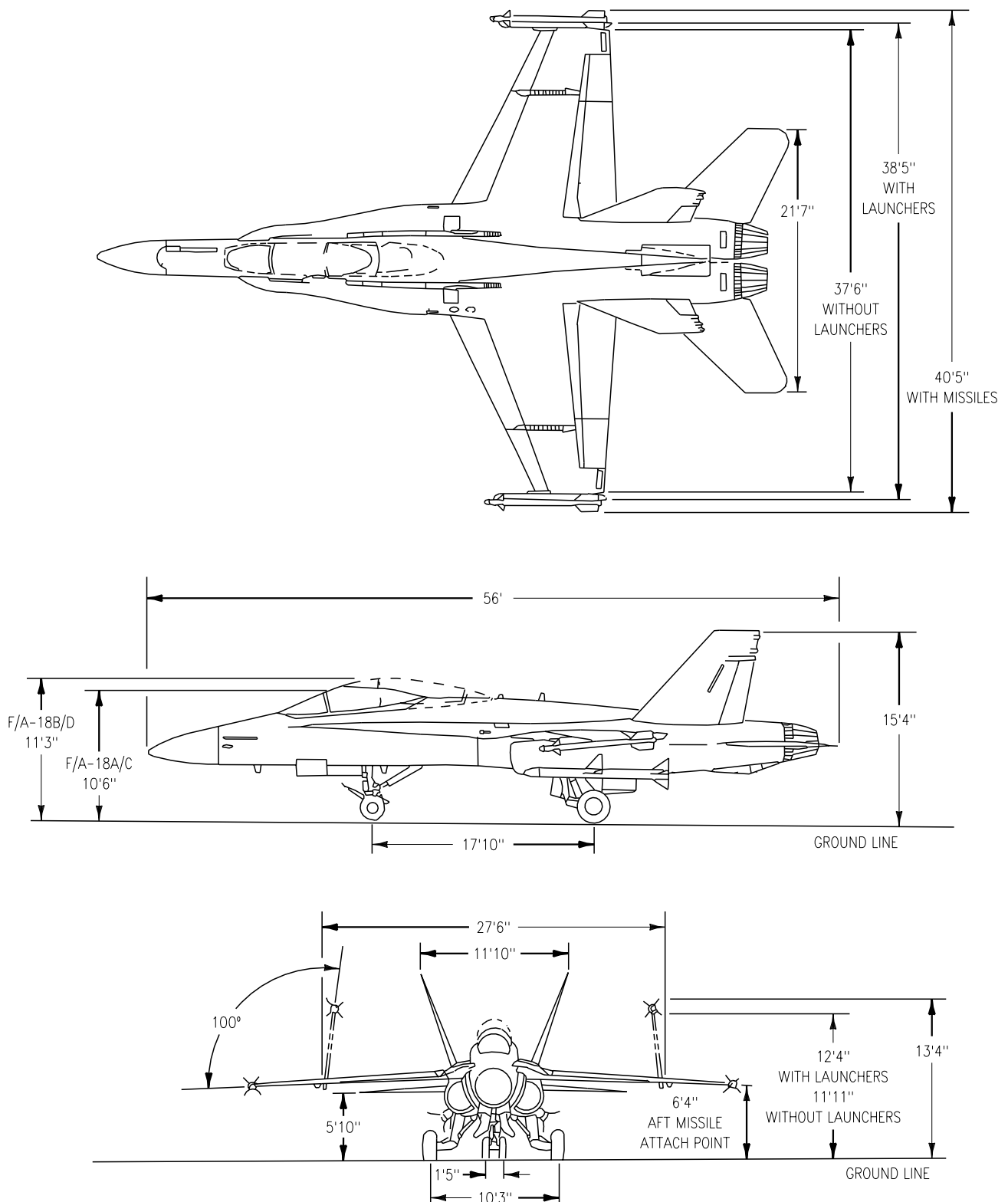


Figure 1. Principal Dimensions

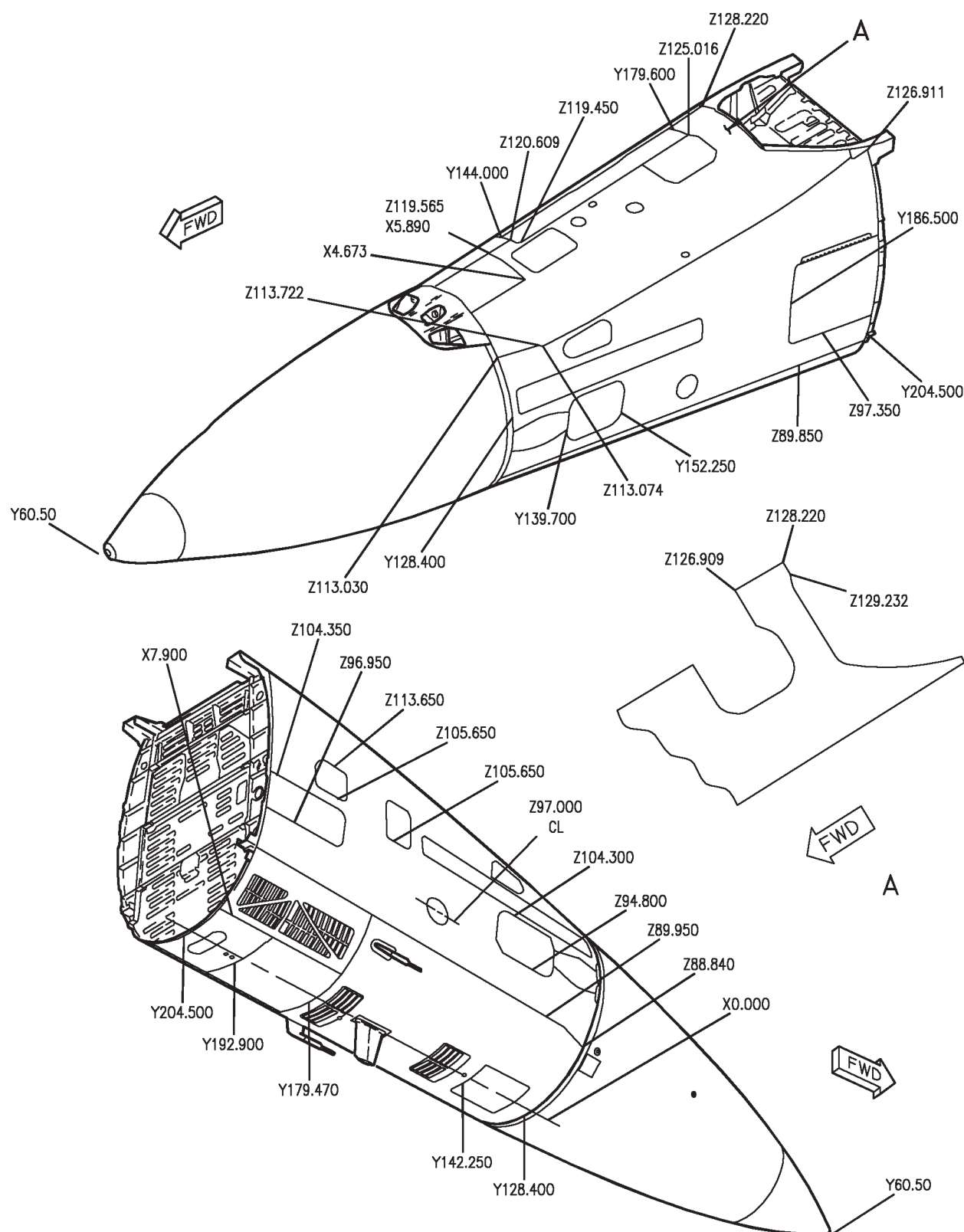
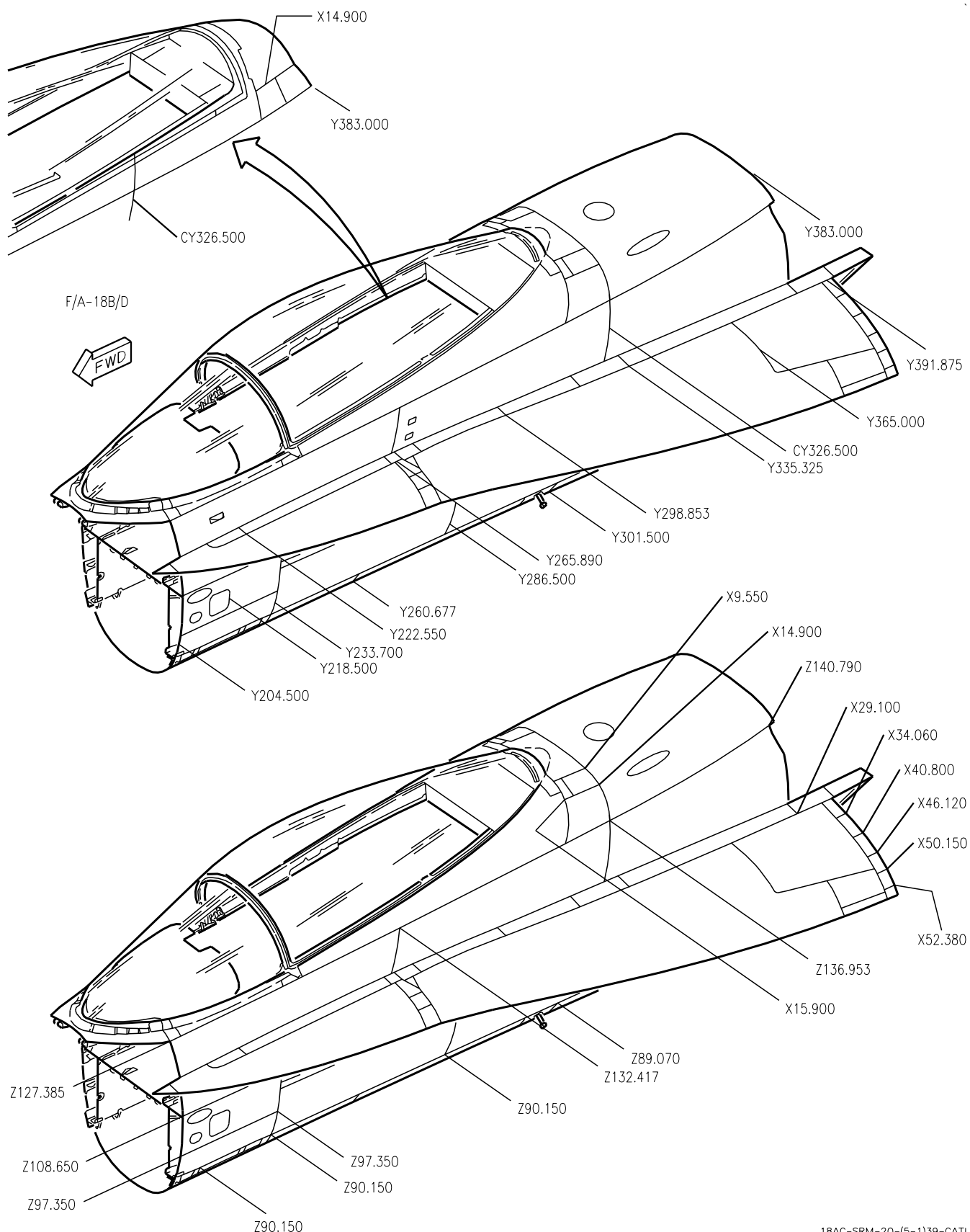
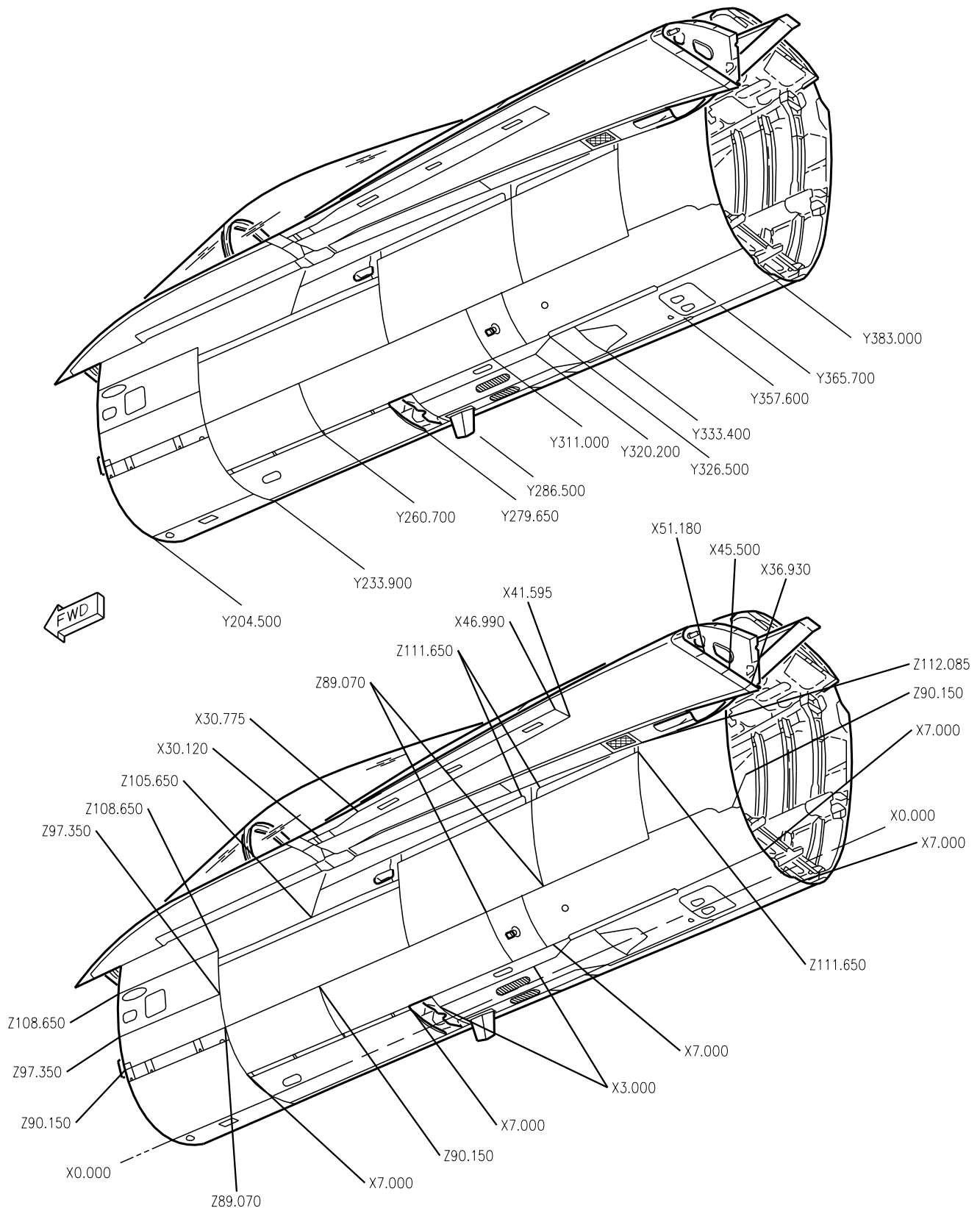


Figure 2. Radome and Nose Barrel



**Figure 3. Forward Fuselage Main Structure Assembly
(Sheet 1)**



**Figure 3. Forward Fuselage Main Structure Assembly
(Sheet 2)**

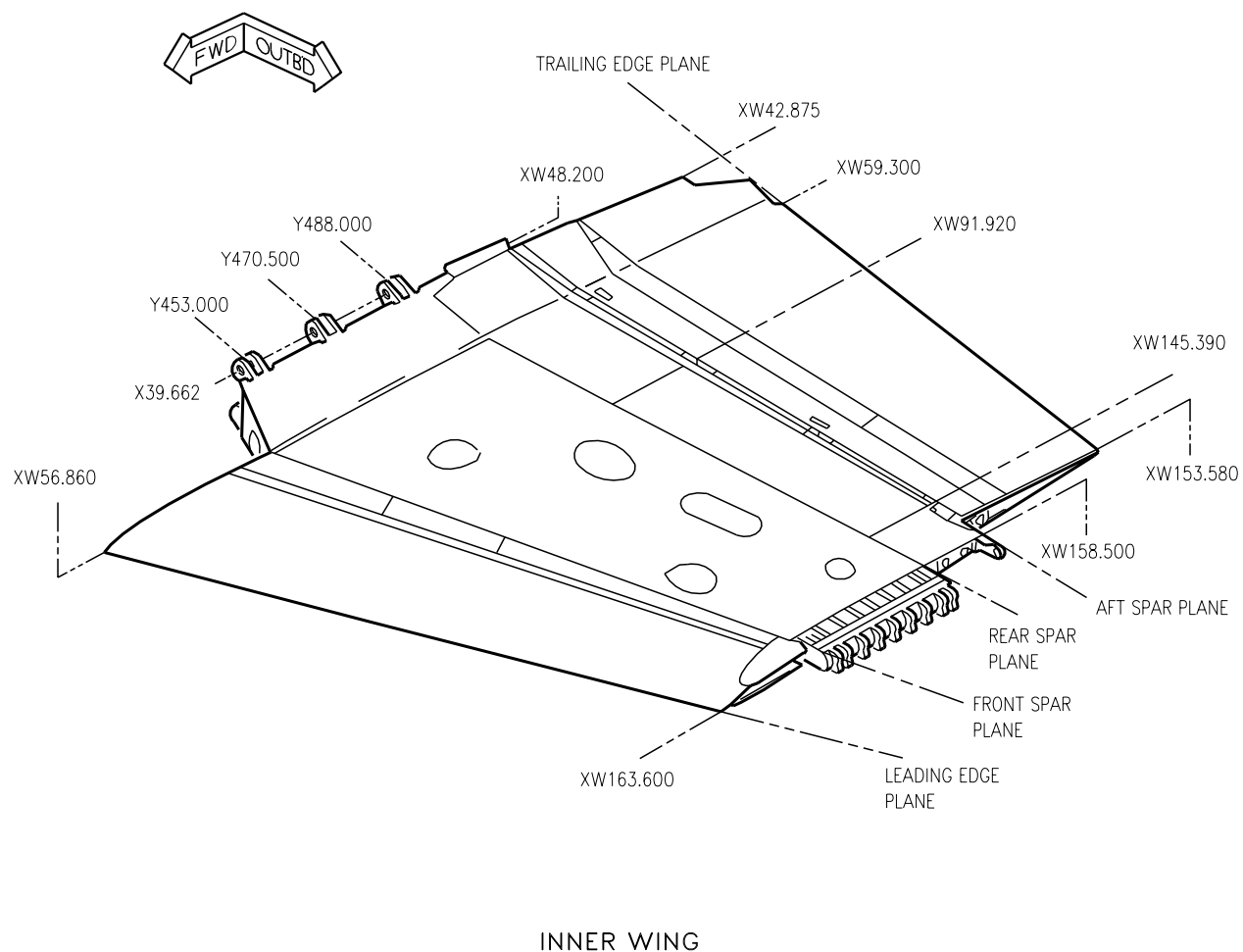


Figure 4. Wing (Sheet 1)

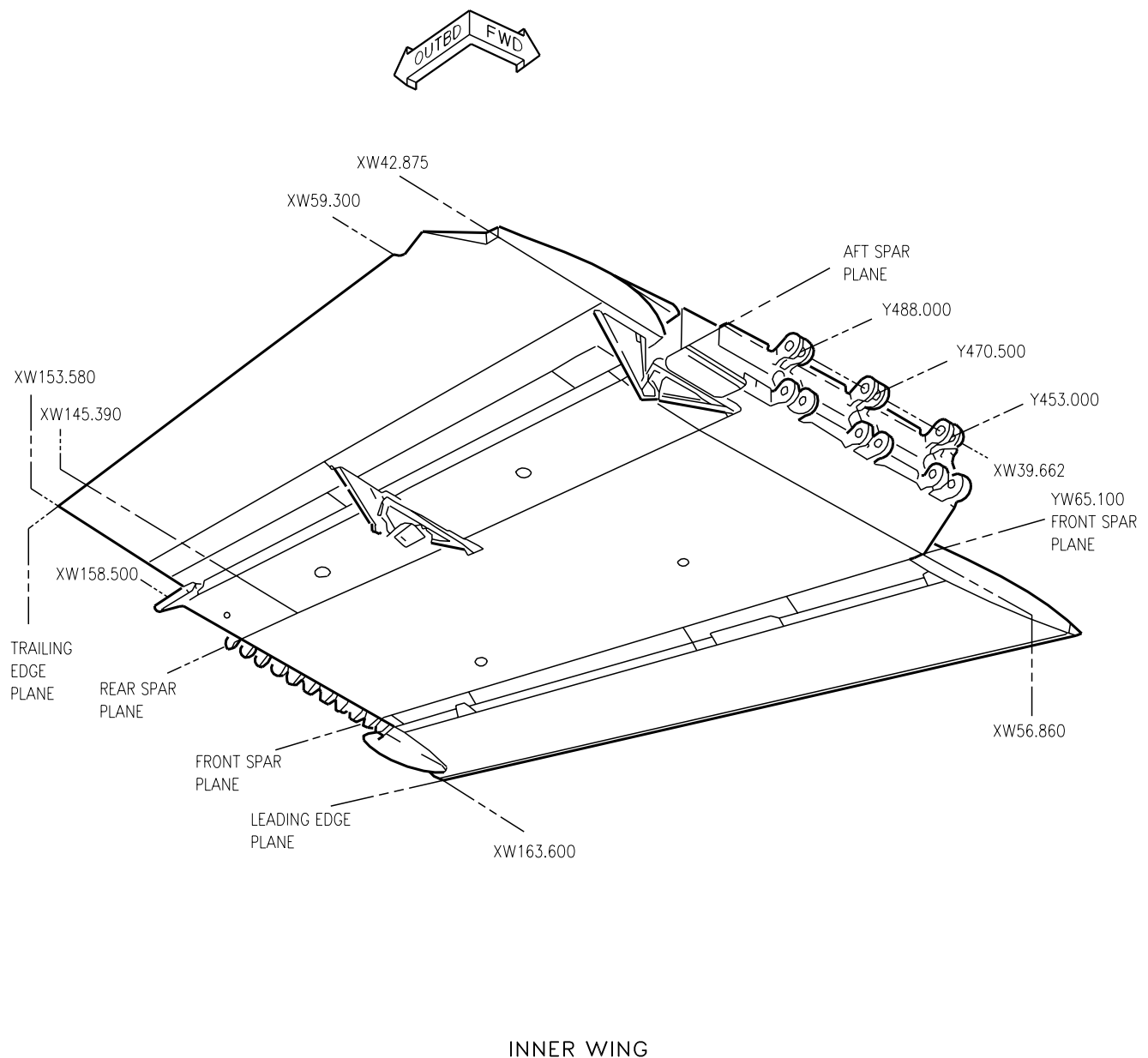


Figure 4. Wing (Sheet 2)

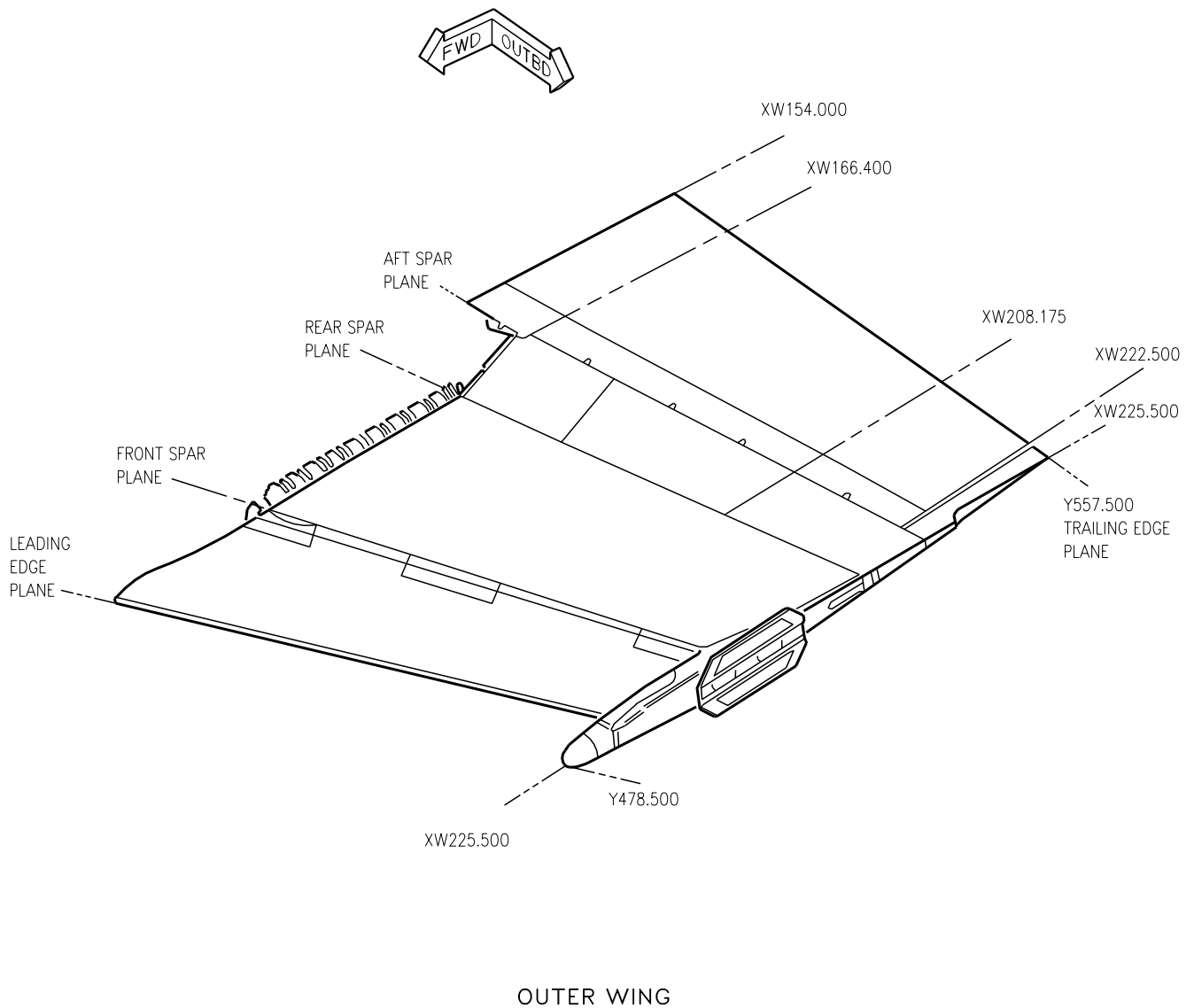


Figure 4. Wing (Sheet 3)

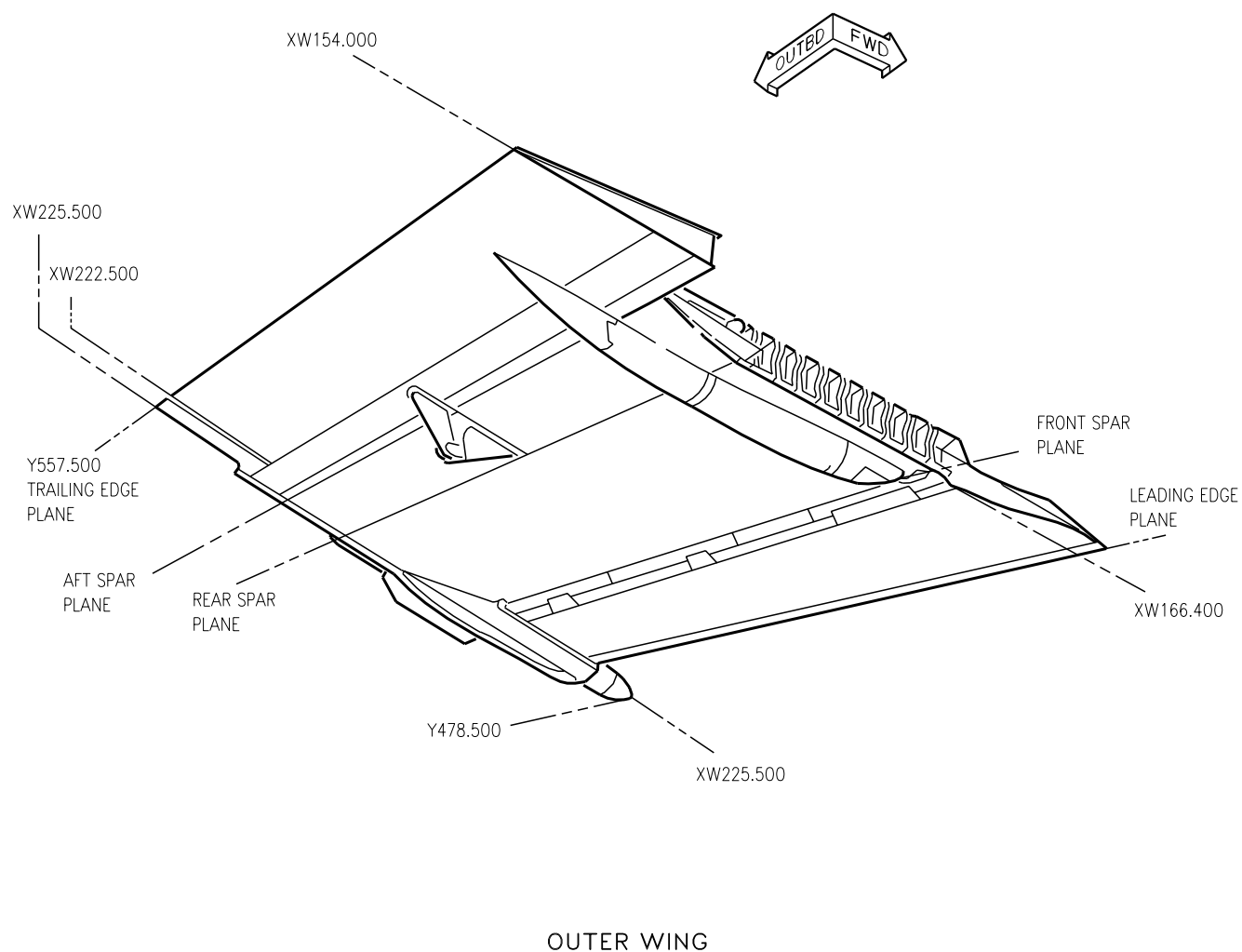


Figure Wing (Sheet 4)

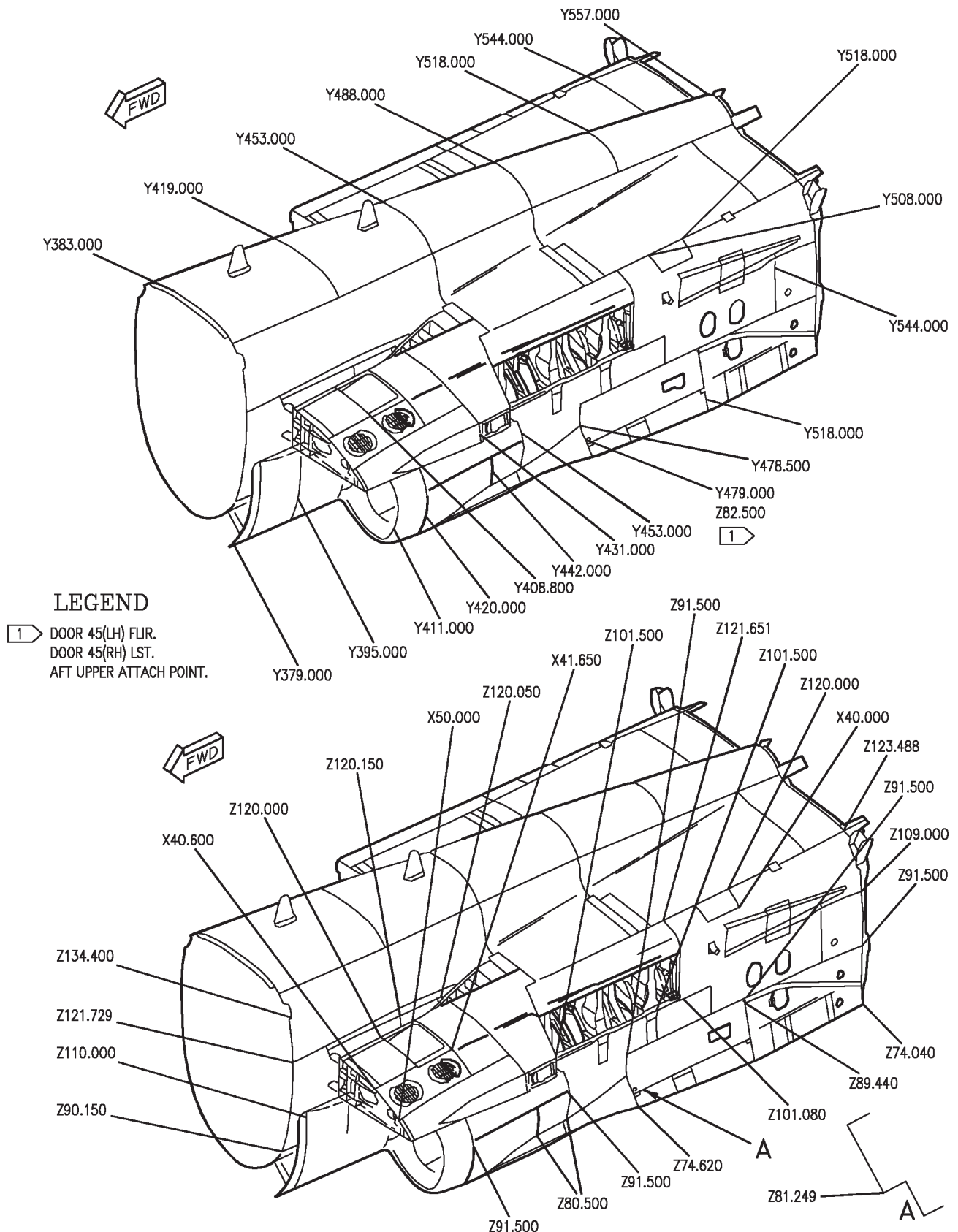


Figure 5. Center Fuselage (Sheet 1)

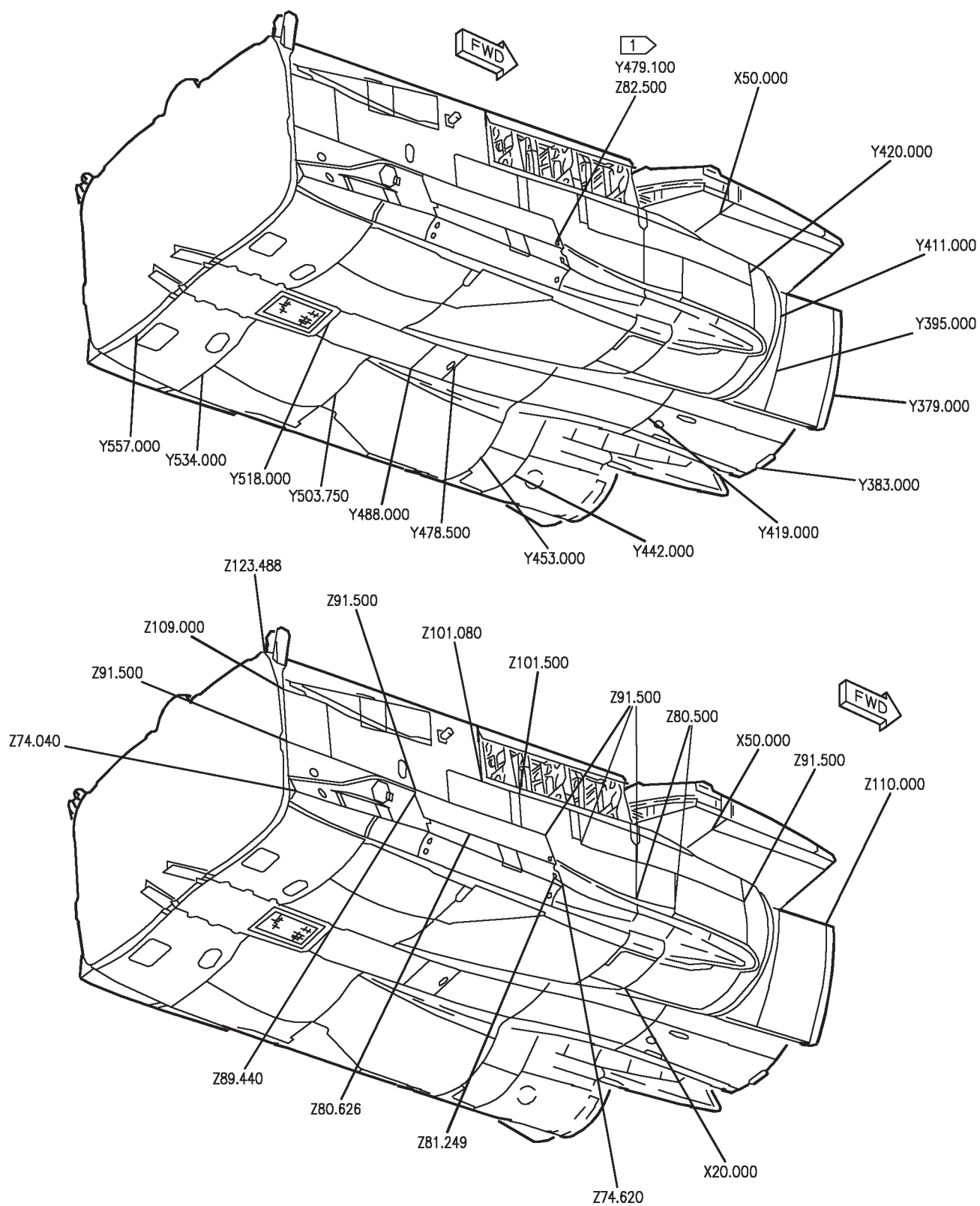


Figure 5. Center Fuselage (Sheet 2)

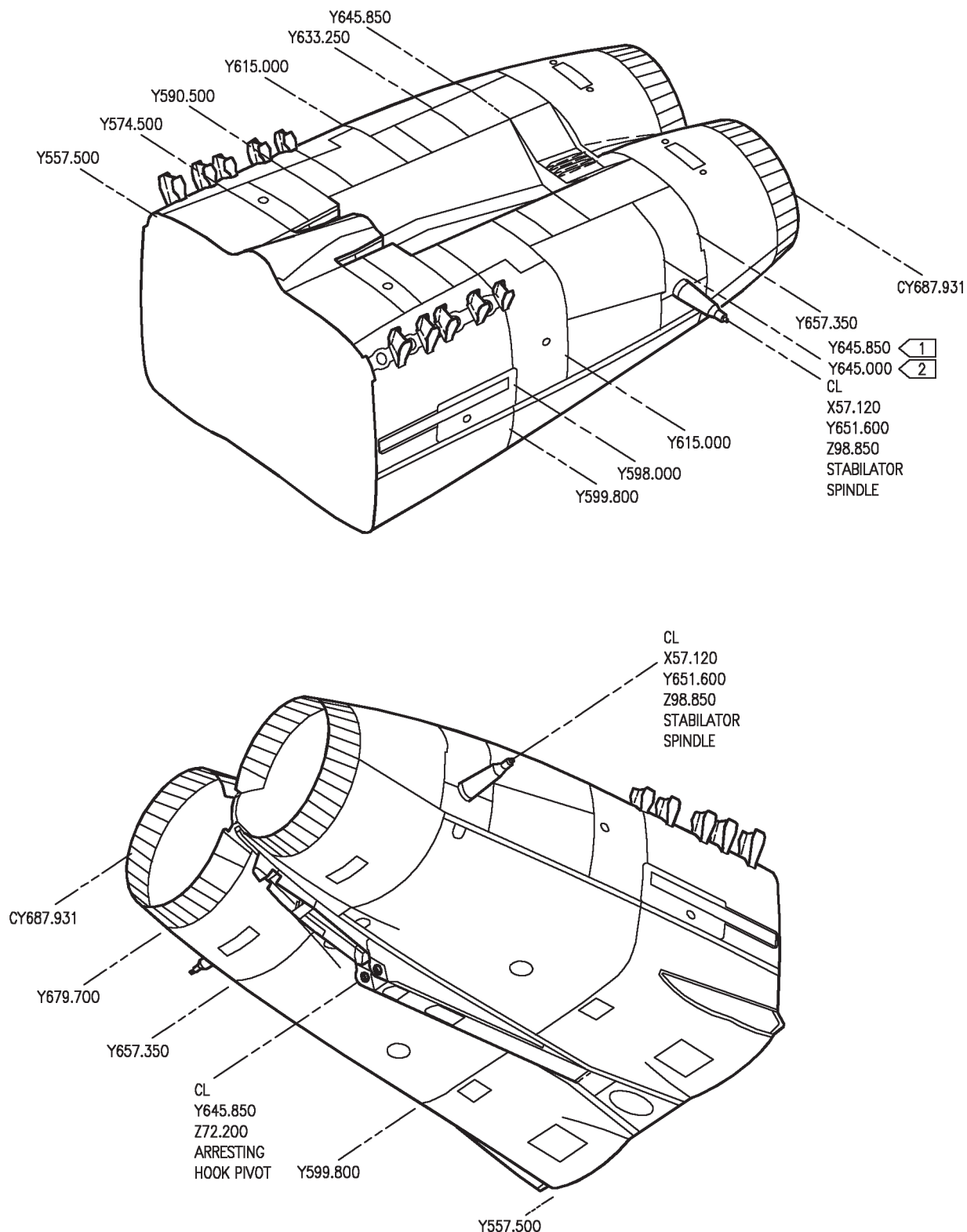


Figure 6. Aft Fuselage (Sheet 1)

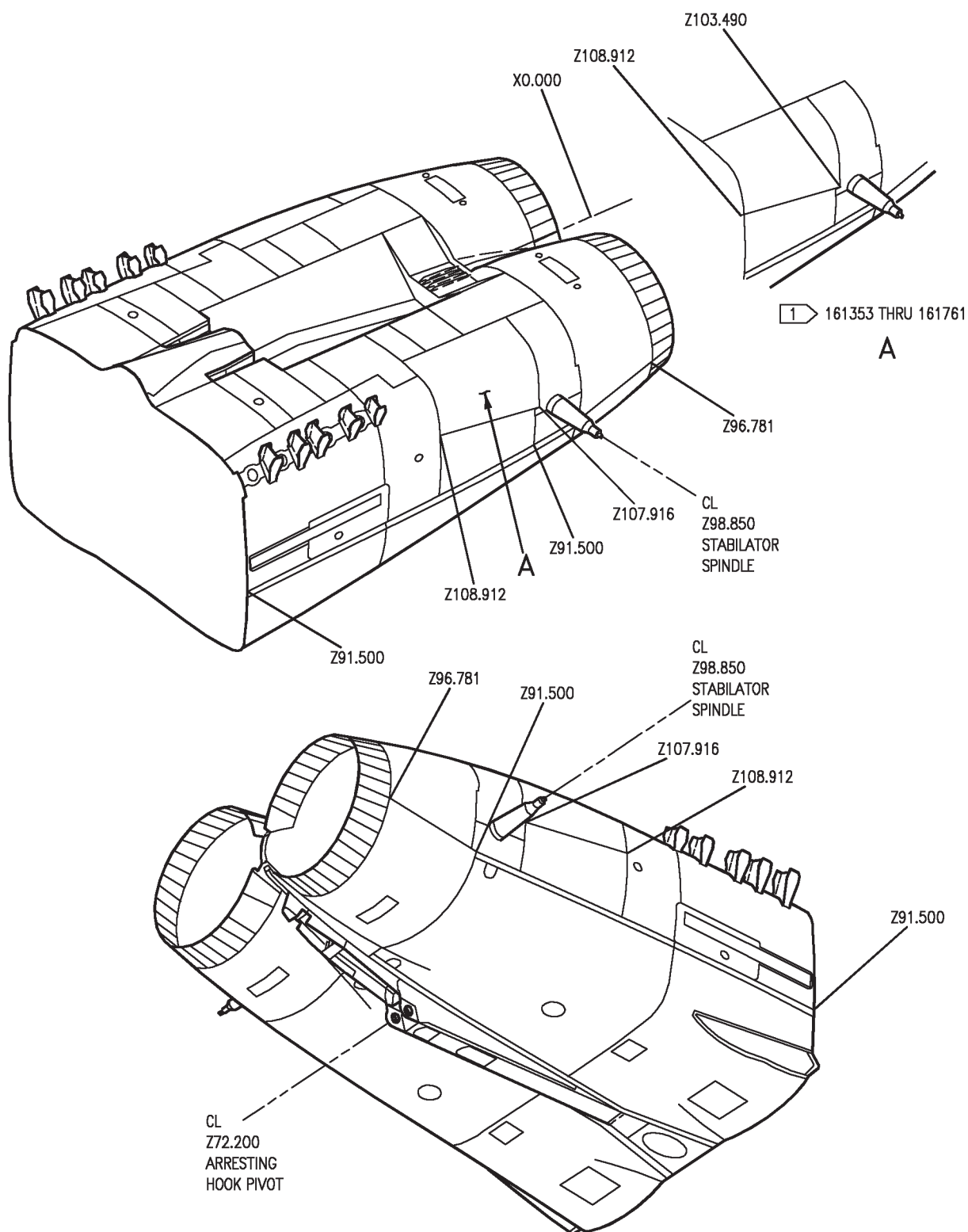


Figure 6. Aft Fuselage (Sheet 2)

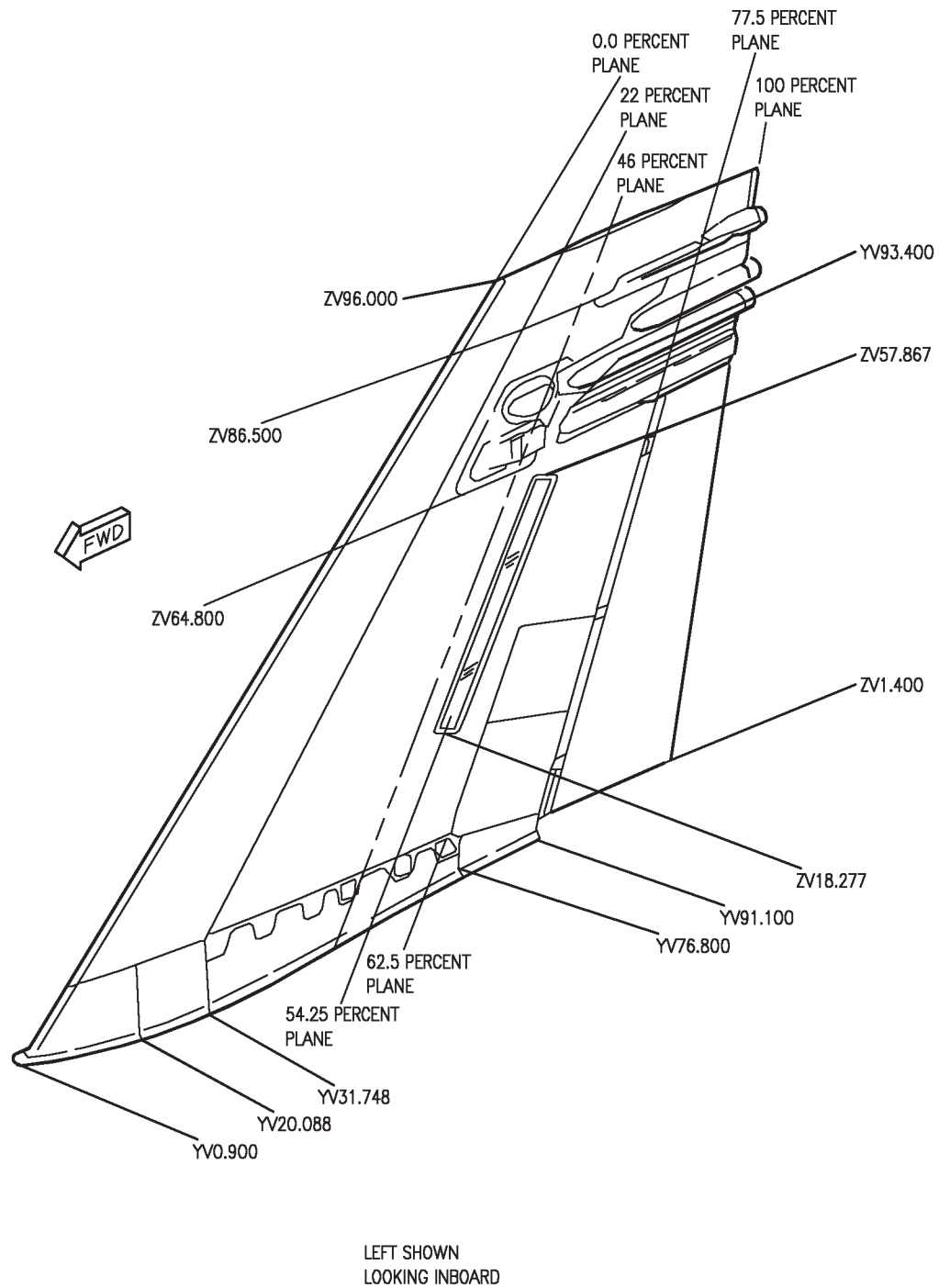


Figure 6. Aft Fuselage (Sheet 3)

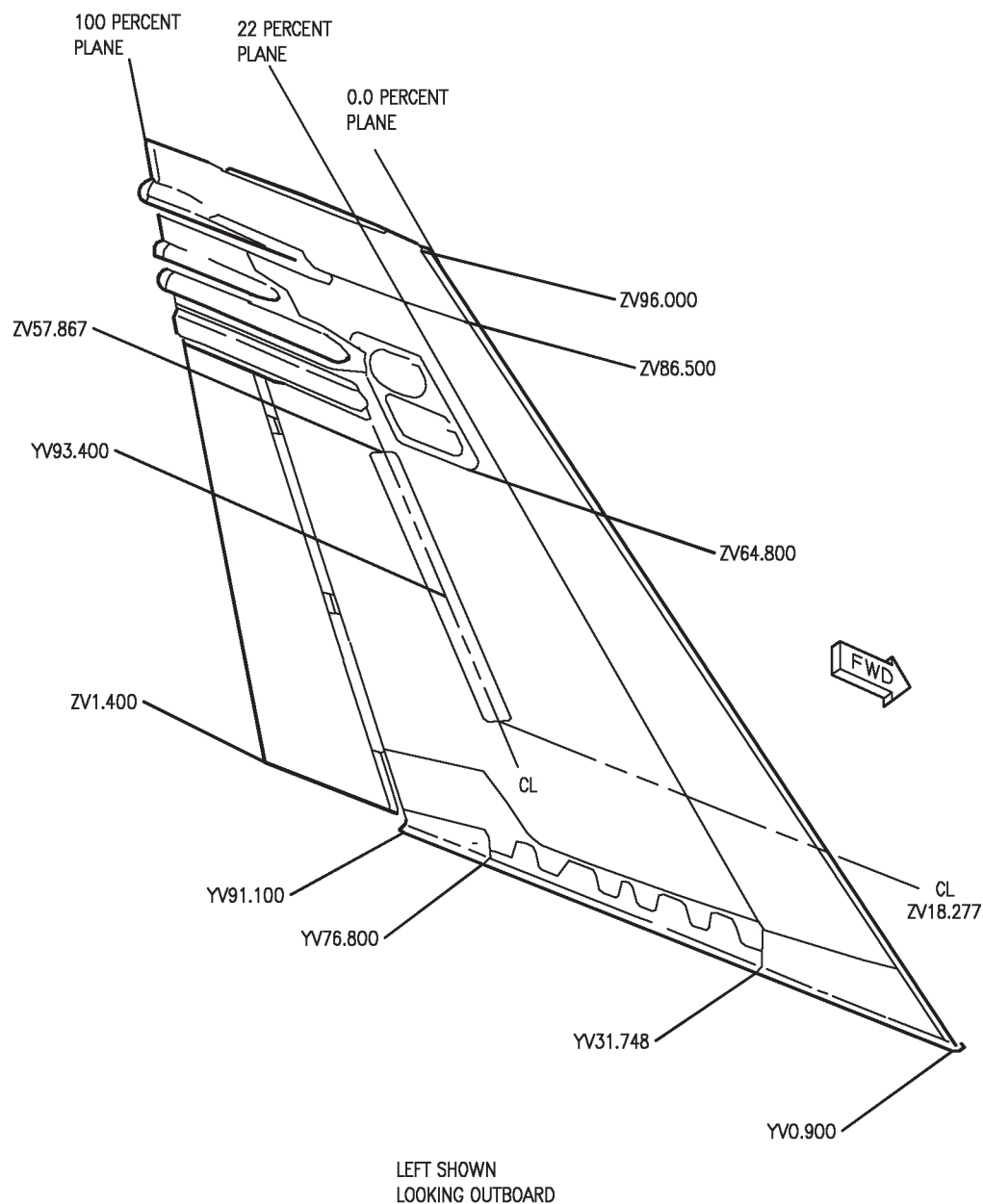


Figure 6. Aft Fuselage (Sheet 4)

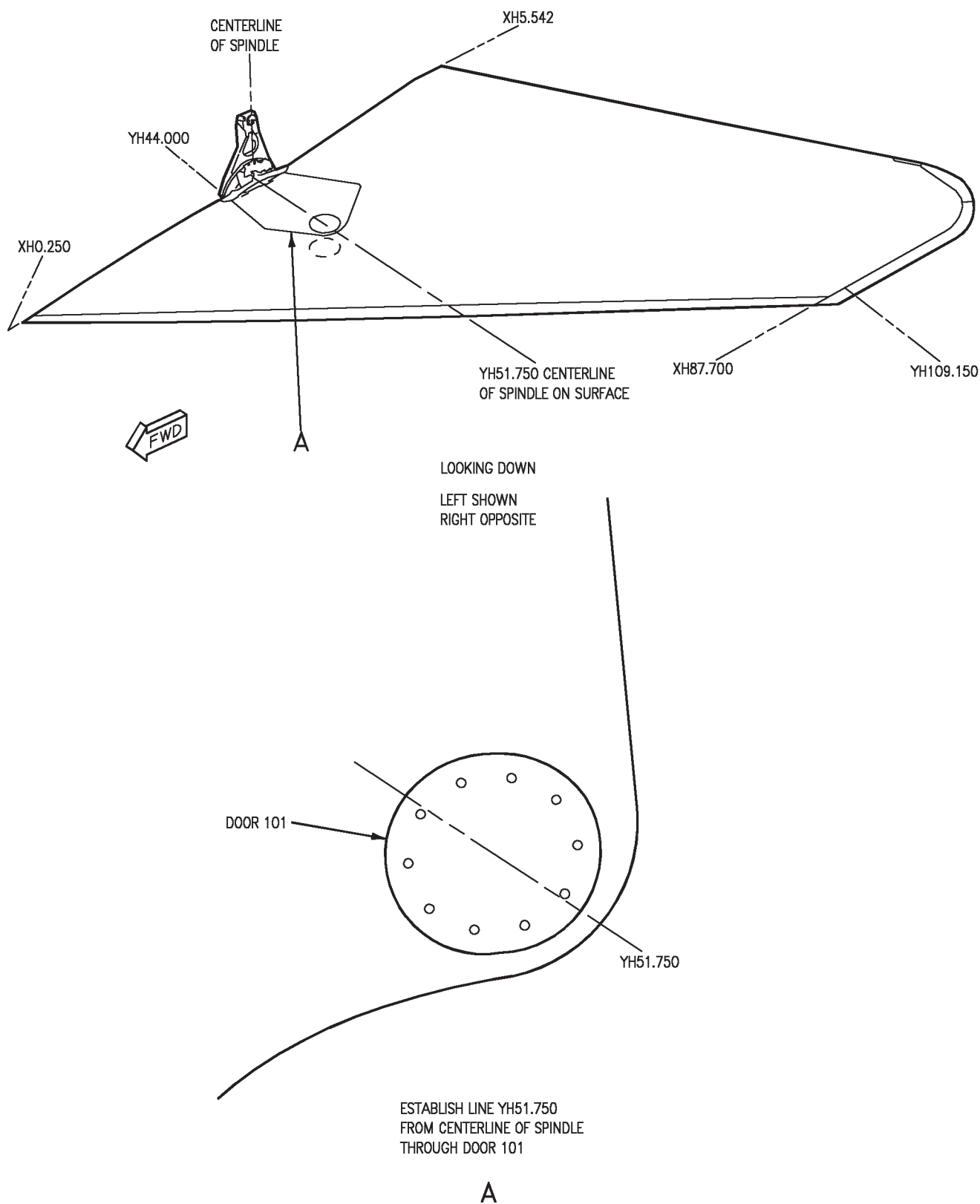
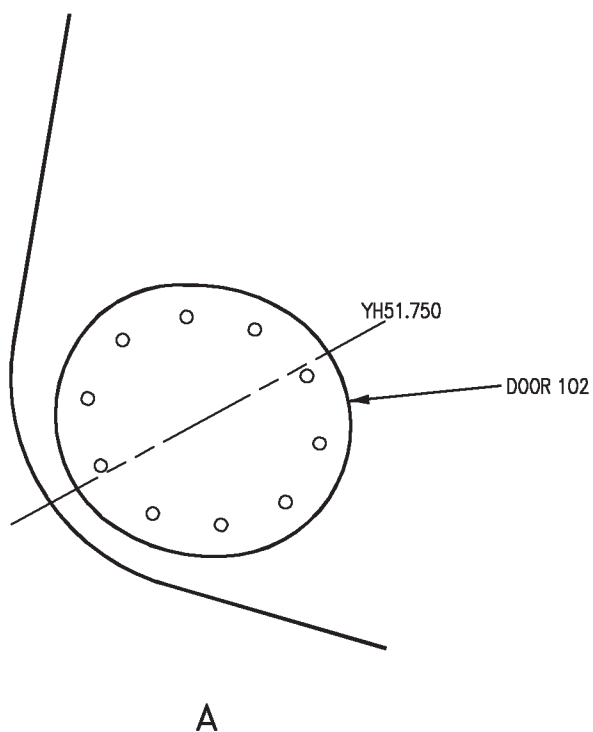
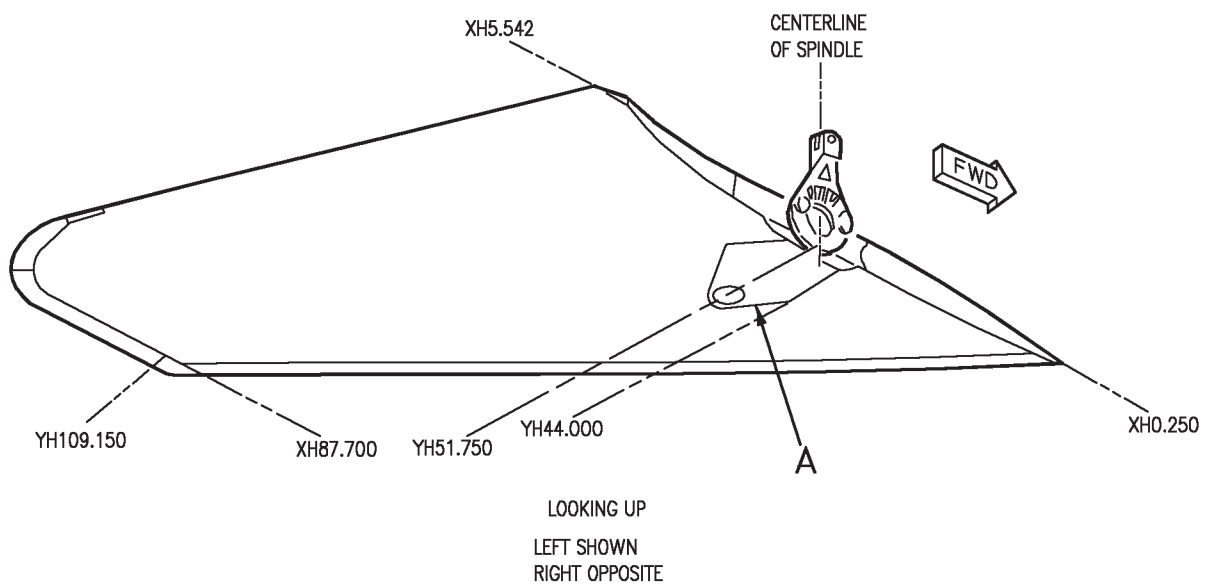


Figure 6. Aft Fuselage (Sheet 5)



LEGEND

1 161924 AND UP

2 161353 THRU 161761

Figure 6. Aft Fuselage (Sheet 6)

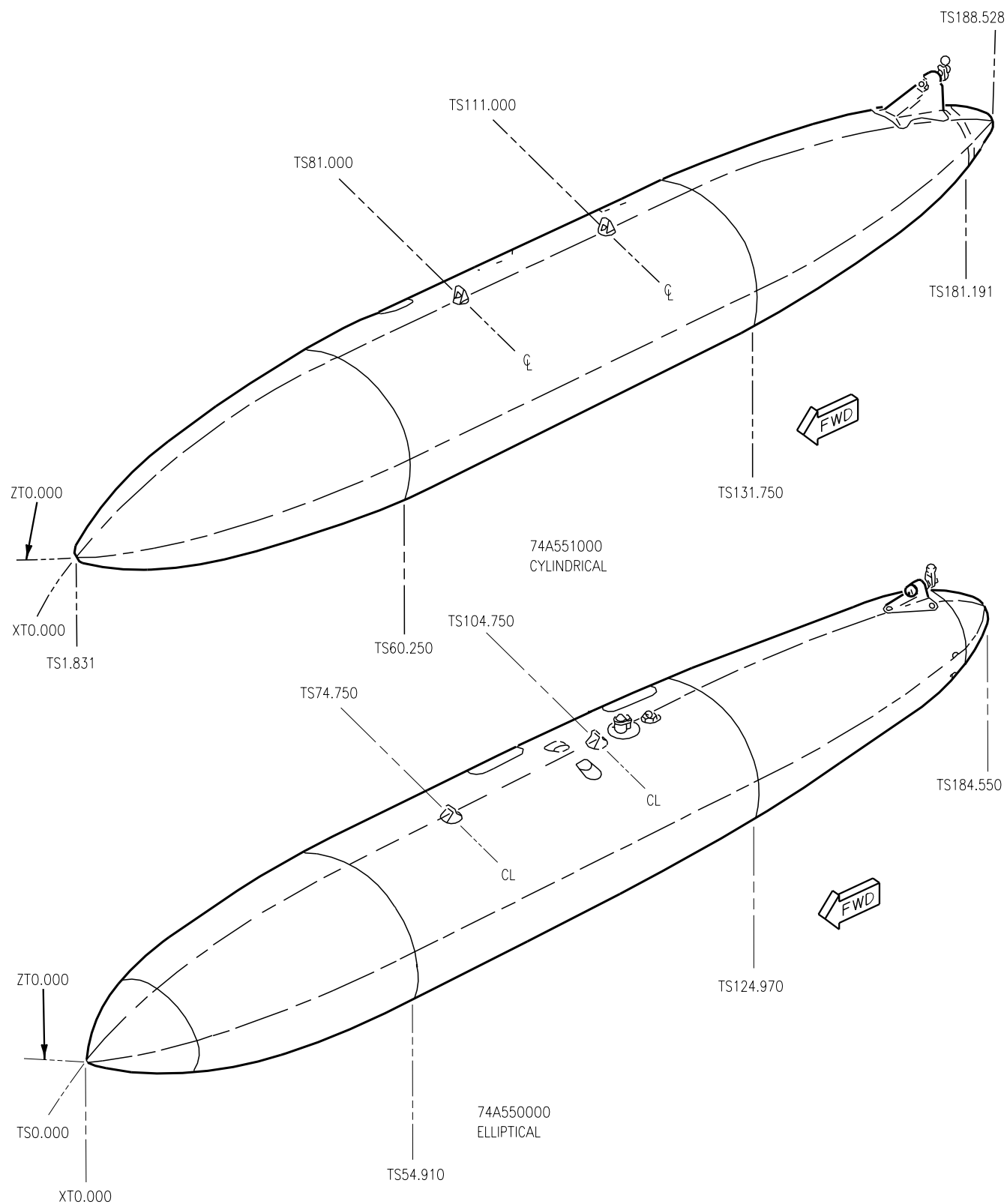


Figure 7. External Fuel Tanks

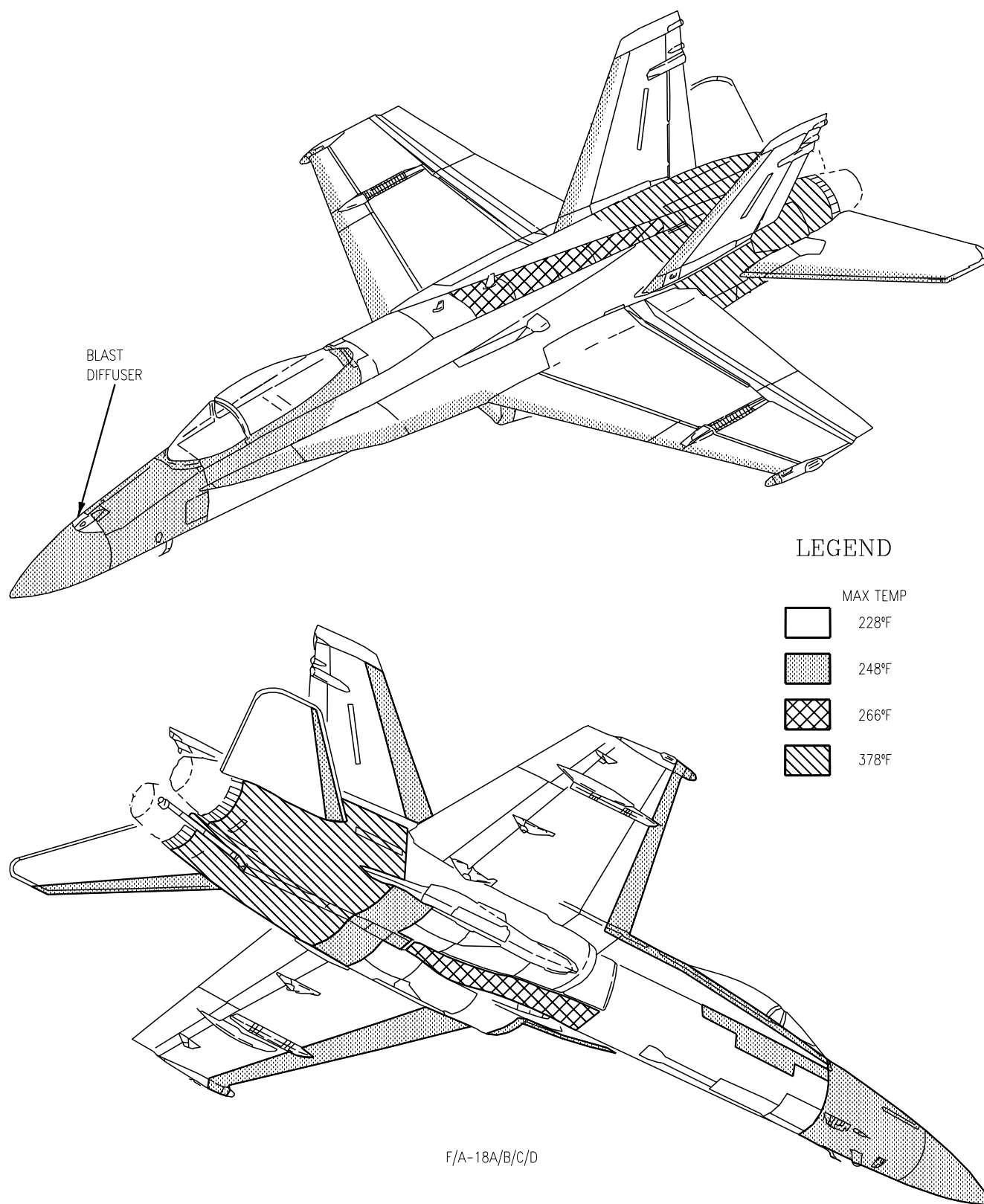


Figure 8. High Temperature Areas

INTERMEDEIATE MAINTENANCE

STRUCTURE REPAIR

SHOP PRACTICES

FLAT PATTERN DEVELOPMENT

This WP supersedes WP004 00, dated 1 January 1995.

Reference Material

None

Alphabetical Index

Subject	Page No.
Introduction	1
Flat Pattern Development	2
Marking Materials	1
Use of Undimensioned Drawings.....	2

Record of Applicable Technical Directives

None

1. INTRODUCTION.

a. Marking materials to mark bare and coated aluminum and steel are listed below:

2. The primary step in preparation for forming parts from sheet metal is pattern development. Bend allowance or bend tangent adjustments are required for good layout application.

3. **MARKING MATERIALS.** The marking materials to be used when marking reference lines for flat pattern development or locating fastener hole patterns are listed below:



Graphite lead pencils shall not be used to mark any bare metal. Graphite lead will cause etch corrosion or carbonization of area marked.

—	Sharpie or Vis-A-Vis Permanent Marker, Red
MIL-P-83953 TY1CLB	Pencil, Aircraft Marking, Yellow
MIL-P-83953 TY1CL2,RED	Pencil, Aircraft Marking, Red
1448BLACK INK, DRAWING	Ink Black
GK-6646-R INK, DRAWING	Ink Purple

b. Marking materials to mark bare and coated steel are listed below:

— Pencil, Phano #71, red

c. Marking materials to mark titanium and anodized aluminum surfaces are listed below:

MIL-P-83953 TY1CLB Pencil, Aircraft
Marking, Yellow

MIL-P-83953 Pencil, Aircraft
TY1CL2,RED Marking, Red

4. USE OF UNDIMENSIONED DRAWINGS.

Undimensioned drawings provide a means of establishing fully coordinated and accurate full-scale views for engineering and tooling purposes. Drawings can be accurately reproduced on material for use in manufacturing and inspection of the part. Reproduction may be made photographically by contact. Reproduction may be made from accurate, full scale prints on sensitized paper, stock for form block, templates, or material from which part itself may be made. Undimensioned drawings may be used for parts described below:

a. Individual sheet metal parts that require a template or flat pattern development.

b. Sheet metal assemblies which are primarily in same plane and follow a lofted contour such as ribs, bulkheads, frames, or when development of parts requires many cuts for development of tooling templates.

c. Closely related sheet metal parts which are not assembled together and stocked as a unit, but are finally assembled on common contour or station lines at a later assembly, such as wing ribs at near by station lines or several sections of one rib on one station line.

5. FLAT PATTERN DEVELOPMENT. Fabrication of aircraft parts is done by forming of flat stock. Before a part is formed, a flat pattern is required to show how much material is required in bend areas, to what point sheet must be inserted into forming tool, or to indicate bend lines. Flat pattern

development of sheet metal parts and terminology commonly related with this type of layout is outlined below:

a. Bend Allowance. Aluminum alloy and sheet steel require a definite length of material to make a bend, depending on thickness of material and bend radius used. Bend allowances can be figured by using bend allowance chart shown in figure 1. This chart gives amount of material needed for each degree of bend when material thickness and bend radius are known. To determine amount of material needed, bend allowance per degree is multiplied by number of degrees in bend. The chart has been developed by using the formula below:

$$BA = (0.01743 \text{ RAD} + 0.0078T)N$$

BA =material required to make the bend.

RAD =inside radius of bend or bend radius.

T =thickness of material

N =number of degrees material will be bent.

b. Bend Tangent Adjustment, see figure 2. This adjustment is arrived at by multiplying sum of bend radius plus material thickness by a factor K. The K factor is taken from figure 2.

c. Layout Application. To illustrate use of bend allowance and bend tangent adjustment charts in figuring amount of material needed for flat pattern layout and locating bend tangent lines, assume the part to be developed is made of 0.071 thick material with bend angles of 120°, 60°, and 90° respectively. The flat pattern of part would be developed as shown in figure 3.

(1) Computations for adjustment at points A, B, and C using K value from chart in figure 2.

(2) Computations for flat areas D, E, F, and G are made by subtracting adjustment from respective mold line measurement.

(3) Computations for finding bend allowances for 60°, 90°, and 120° bend using information from chart shown in figure 3.

- (4) Flat pattern layout of part.

NOTE

Do not use a scribe to mark bend lines on part as this will cause metal to crack when bent. Use aircraft marking material.

d. Bend lines. After flat pattern has been cut to shape with bend tangent lines indicated, bend lines marked on part are needed to indicate where edge of forming tool must be aligned on part to make bend. Bend lines are located differently for cornice or V-brake as listed below:

NOTE

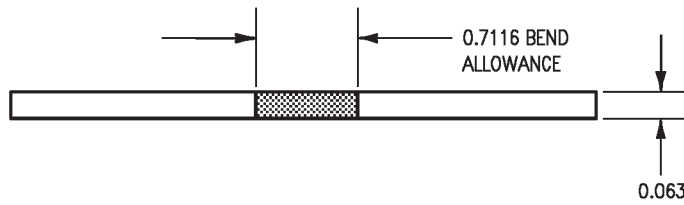
Radius of V-brake die, cornice brake jaw, or hand forming blocks shall be same as bend radius of flat pattern.

- (1) When cornice brake is used, bend line shall be at a distance equal to bend radius away

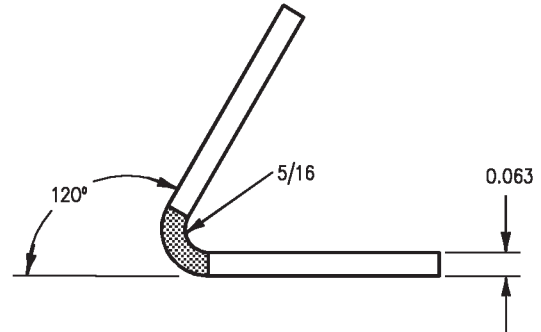
from one bend tangent line, depending upon direction in which part is to be bent. Follow this rule for any degree bend. The procedure for lining up material in bending tool is shown in figure 4. Line up bend line with nose of bending tool by eye or by using a combination square. If bend is made with form blocks, bend line is to line up with edge of form blocks.

- (2) On parts formed on V-brake, bend line is midway between bend tangent lines and is located at center of brake anvil and upper die.

EXAMPLE



TO DETERMINE TOTAL BEND ALLOWANCE, FIND BEND ALLOWANCE FOR ONE DEGREE IN COLUMN 0.063 OPPOSITE 5/16 INCH "BEND RADIUS" COLUMN. MULTIPLY BEND ALLOWANCE FOR ONE DEGREE BY NUMBER OF DEGREES OF BEND.
EXAMPLE: $0.00593 \times 120 = 0.7116$ (TOTAL BEND ALLOWANCE).



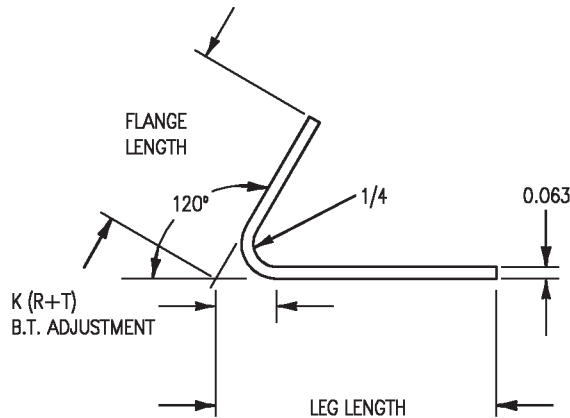
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BEND ALLOWANCE PER DEGREE OF BEND

BEND RADIUS	MATERIAL THICKNESS (INCHES)											
	0.020	0.025	0.032	0.040	0.050	0.063	0.071	0.080	0.090	0.100	0.125	0.190
1/32	0.00070	0.00074	0.00079	0.00085	0.00093	0.00104	0.00110	0.00117	0.00125	0.00132	0.00154	0.00202
1/16	0.00125	0.00129	0.00134	0.00140	0.00148	0.00158	0.00164	0.00171	0.00180	0.00187	0.00209	0.00256
3/32	0.00179	0.00183	0.00188	0.00195	0.00202	0.00212	0.00219	0.00226	0.00233	0.00242	0.00263	0.00312
1/8	0.00233	0.00237	0.00243	0.00249	0.00257	0.00267	0.00273	0.00282	0.00288	0.00296	0.00315	0.00366
5/32	0.00288	0.00292	0.00297	0.00303	0.00311	0.00321	0.00327	0.00334	0.00342	0.00350	0.00370	0.00420
3/16	0.00342	0.00347	0.00352	0.00358	0.00366	0.00375	0.00382	0.00389	0.00397	0.00404	0.00424	0.00475
7/32	0.00397	0.00401	0.00406	0.00412	0.00420	0.00430	0.00436	0.00443	0.00451	0.00459	0.00479	0.00529
1/4	0.00451	0.00455	0.00461	0.00467	0.00475	0.00484	0.00491	0.00498	0.00505	0.00513	0.00533	0.00583
9/32	0.00506	0.00510	0.00515	0.00521	0.00529	0.00539	0.00545	0.00552	0.00560	0.00568	0.00588	0.00638
5/16	0.00560	0.00564	0.00570	0.00576	0.00584	0.00593	0.00599	0.00606	0.00614	0.00622	0.00642	0.00692
11/32	0.00615	0.00619	0.00624	0.00630	0.00638	0.00647	0.00654	0.00661	0.00669	0.00676	0.00697	0.00747
3/8	0.00669	0.00673	0.00679	0.00685	0.00693	0.00702	0.00708	0.00715	0.00723	0.00731	0.00751	0.00774
13/32	0.00724	0.00728	0.00733	0.00739	0.00748	0.00756	0.00763	0.00770	0.00777	0.00785	0.00806	0.00856
7/16	0.00778	0.00782	0.00788	0.00794	0.00802	0.00811	0.00817	0.00824	0.00832	0.00840	0.00840	0.00910
15/32	0.00833	0.00837	0.00842	0.00848	0.00856	0.00865	0.00871	0.00878	0.00886	0.00894	0.00914	0.00964
1/2	0.00887	0.00891	0.00896	0.00903	0.00910	0.00919	0.00926	0.00933	0.00941	0.00948	0.00969	0.01019
17/32	0.00941	0.00945	0.00951	0.00957	0.00965	0.00974	0.00980	0.00987	0.00995	0.01003	0.01023	0.01073
9/16	0.00996	0.01000	0.01005	0.01012	0.01019	0.01028	0.01034	0.01042	0.01049	0.01057	0.01078	0.01127
19/32	0.01050	0.01054	0.01060	0.01066	0.01074	0.01083	0.01089	0.01096	0.01104	0.01112	0.01132	0.01182
5/8	0.01105	0.01109	0.01114	0.01121	0.01128	0.01137	0.01143	0.01150	0.01158	0.01166	0.01187	0.01236
21/32	0.01159	0.01163	0.01169	0.01175	0.01183	0.01191	0.01198	0.01205	0.01213	0.01220	0.01241	0.01291
11/16	0.01214	0.01218	0.01223	0.01230	0.01238	0.01248	0.01258	0.01261	0.01269	0.01281	0.01298	0.01351
23/32	0.01268	0.01273	0.01276	0.01283	0.01291	0.01301	0.01310	0.01316	0.01322	0.01333	0.01351	0.01403
3/4	0.01323	0.01327	0.01332	0.01338	0.01347	0.01357	0.01363	0.01370	0.01378	0.01385	0.01407	0.01455
25/32	0.01378	0.01381	0.01386	0.01392	0.01401	0.01411	0.01415	0.01425	0.01432	0.01437	0.01461	0.01508
13/16	0.01432	0.01436	0.01441	0.01447	0.01456	0.01466	0.01471	0.01479	0.01487	0.01493	0.01516	0.01564
27/32	0.01486	0.01490	0.01494	0.01501	0.01509	0.01519	0.01520	0.01534	0.01540	0.01542	0.01569	0.01612
7/8	0.01541	0.01545	0.01550	0.01556	0.01565	0.01575	0.01582	0.01588	0.01596	0.01619	0.01625	0.01682
29/32	0.01595	0.01599	0.01604	0.01610	0.01619	0.01629	0.01639	0.01643	0.01650	0.01664	0.01679	0.01734
15/16	0.01650	0.01654	0.01659	0.01665	0.01674	0.01684	0.01693	0.01697	0.01705	0.01716	0.01734	0.01786
31/32	0.01704	0.01708	0.01712	0.01718	0.01727	0.01737	0.01746	0.01752	0.01758	0.01769	0.01787	0.01839
1	0.01759	0.01763	0.01768	0.01774	0.01783	0.01793	0.01798	0.01806	0.01814	0.01821	0.01843	0.02191

Figure 1. Bend Allowance

EXAMPLE

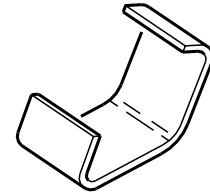
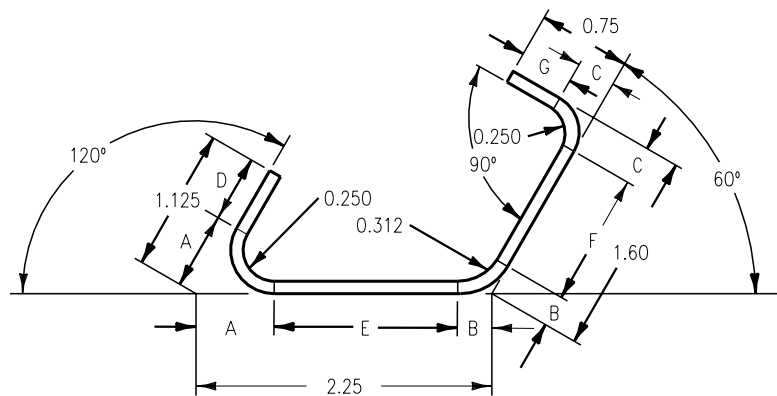


ANGLE OF BEND -----120 DEGREES
 MATERIAL THICKNESS (T)-----0.063
 BEND RADIUS (R) -----0.250
 K FROM TABLE -----1.7320
 BEND TANGENT ADJUSTMENT
 =K (R+T)
 =1.7320 (0.250 + 0.063)
 =1.7320 X 0.313
 =0.542 INCH

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ANGLE DEGREE	K	ANGLE DEGREE	K	ANGLE DEGREE	K	ANGLE DEGREE	K	ANGLE DEGREE	K	ANGLE DEGREE	K
1	0.00873	31	0.27732	61	0.58904	91	1.0176	121	1.7675	151	3.8667
2	0.01745	32	0.28674	62	0.60086	92	1.0355	122	1.8040	152	4.0108
3	0.02618	33	0.29621	63	0.61208	93	1.0538	123	1.8418	153	4.1653
4	0.03493	34	0.30573	64	0.62487	94	1.0727	124	1.8807	154	4.3315
5	0.04366	35	0.31530	65	0.63707	95	1.0913	125	1.9210	155	4.5107
6	0.05241	36	0.32492	66	0.64941	96	1.1106	126	1.9626	156	4.7046
7	0.06116	37	0.33459	67	0.66188	97	1.1303	127	2.0057	157	4.9151
8	0.06993	38	0.34433	68	0.67451	98	1.1504	128	2.0503	158	5.1455
9	0.07878	39	0.35412	69	0.68728	99	1.1708	129	2.0965	159	5.3995
10	0.08749	40	0.36397	70	0.70021	100	1.1917	130	2.1445	160	5.6713
11	0.09629	41	0.37388	71	0.71329	101	1.2131	131	2.1943	161	5.9758
12	0.10510	42	0.38386	72	0.72654	102	1.2349	132	2.2460	162	6.3137
13	0.11393	43	0.39391	73	0.73996	103	1.2572	133	2.2998	163	6.6911
14	0.12278	44	0.40403	74	0.75355	104	1.2799	134	2.3558	164	7.1154
15	0.13165	45	0.41421	75	0.76733	105	1.3032	135	2.4142	165	7.5957
16	0.14054	46	0.42447	76	0.78128	106	1.3270	136	2.4751	166	8.1443
17	0.14945	47	0.43481	77	0.79543	107	1.3514	137	2.5386	167	8.7769
18	0.15838	48	0.44523	78	0.80978	108	1.3764	138	2.6051	168	9.5144
19	0.16734	49	0.45573	79	0.82434	109	1.4019	139	2.6746	169	10.385
20	0.17633	50	0.46631	80	0.83910	110	1.4281	140	2.7475	170	11.430
21	0.18534	51	0.47697	81	0.85408	111	1.4550	141	2.8239	171	12.706
22	0.19438	52	0.48773	82	0.86929	112	1.4826	142	2.9042	172	14.301
23	0.20345	53	0.49858	83	0.88472	113	1.5108	143	2.9887	173	16.350
24	0.22169	55	0.52057	85	0.91633	115	1.5697	145	3.1716	175	22.904
25	0.23087	56	0.53171	86	0.93251	116	1.6003	146	3.2708	176	26.636
27	0.24008	57	0.54295	87	0.94896	117	1.6318	147	3.3759	177	38.188
28	0.24933	58	0.55431	88	0.96569	118	1.6643	148	3.4874	178	57.290
29	0.25862	59	0.56577	89	0.98270	119	1.6977	149	3.6059	179	114.590
30	0.26795	60	0.57737	90	1.00000	120	1.7320	150	3.7320	180	INFINITE

Figure 2. Bend Tangent Adjustment



EXAMPLE
MATERIAL - 2024-T3 ALCLAD
THICKNESS - 0.071

STEP 1

DETERMINE BEND TANGENT ADJUSTMENT

ADJUSTMENT COMPUTATIONS

ADJUSTMENT = "K" VALUE X BEND RADIUS (R) + MATERIAL THICKNESS (T) (SEE FIGURE 2 FOR "K" VALUE)

BTA AT A = $K(R+T)$
BTA AT A = $1.7320(0.250 + 0.071)$
BTA AT A = 1.7320×0.321
BTA AT A = 0.556

BTA AT B = $K(R+T)$
BTA AT B = $0.5773(0.312 + 0.071)$
BTA AT B = 0.5773×0.363
BTA AT B = 0.221

BTA AT C = $K(R+T)$
BTA AT C = $1(0.250 + 0.071)$
BTA AT C = 1×0.321
BTA AT C = 0.321

STEP 3

DETERMINE BEND ALLOWANCE

BEND ALLOWANCE COMPUTATIONS

BEND ALLOWANCE (BA) = NUMBER OF DEGREES IN BEND X BEND ALLOWANCE PER DEGREE
(SEE FIGURE 2 FOR BEND ALLOWANCE PER DEGREE)

BA FOR 120° BEND = 120 (BA PER DEGREE)
BA FOR 120° BEND = 120×0.00491
BA FOR 120° BEND = 0.589

BA FOR 60° BEND = 60 (BA PER DEGREE)
BA FOR 60° BEND = 60×0.00599
BA FOR 60° BEND = 0.359

BA FOR 90° BEND = 90 (BA PER DEGREE)
BA FOR 90° BEND = 90×0.00491
BA FOR 90° BEND = 0.442

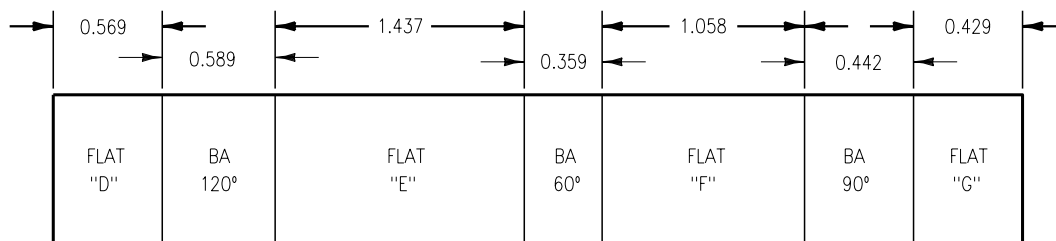
STEP 4
LAYOUT

Figure 3. Layout Development

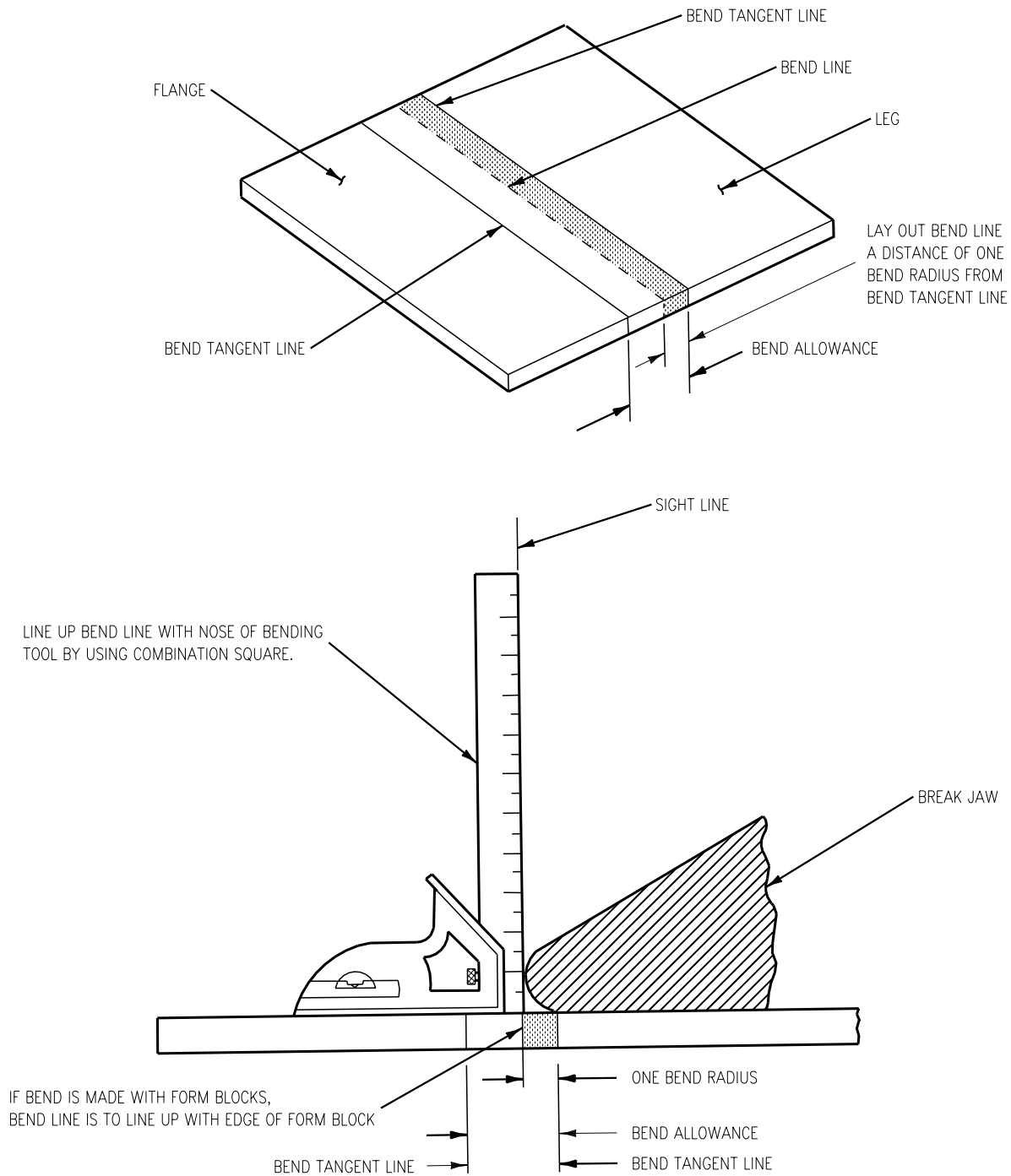


Figure 4. Use of Bend Lines on Cornice Brake

INTERMEDIATE MAINTENANCE

STRUCTURE REPAIR

SHOP PRACTICES

FORMING SHEET METAL

Reference Material

General Manual For Structural Repair	NAVAIR 01-1A-1
Structure Repair, General Information	A1-F18AC-SRM-200
Flat Pattern Development	WP004 00

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Record of Applicable Technical Directives

None

1. INTRODUCTION.

2. Forming is an operation which changes surface contour of material. This change is completed by stretching or shrinking material in certain areas to produce curves, flanges, or other irregular shapes. Since forming involves changing shape of stock material, amount of shrinking and stretching depends mostly on type of material used. This WP should be used with NAVAIR 01-1A-1.

3. SHEET METAL FORMING.

a. Some forming of aluminum alloy sheet may be done in heat treated condition. Forming in this condition deletes the process of straightening or line-up, to remove warp or twist caused by heat treating. However, formability in heat treated condition is limited.

b. Parts having straight or nearly straight bends, single flanged lightening holes in thin material, shallow joggles, or parts having single curvature may generally be formed in heat treated condition.

c. When large bends and forming radii, required for materials formed in heat treated condition are not practical, forming operation shall be done on material in "O" or annealed condition. However, in no case may 2024 or 7075 aluminum alloy in "O" or annealed condition be used on an aircraft. When "O" condition material is used to make a part, it must be heat treated before use. Straight parts, having beads, curved bend lines, deep joggles, return flange lightening holes, embossed areas, or compound curvature shall be formed of 2024 and 7075 aluminum alloy in "O" condition, or; if steel, in annealed condition.

d. Before forming part(s) make sure all equipment is in correct operating condition.

(1) Inspect holding surfaces of brakes and presses for nicks, gauges, dirt, and security.

(2) Inspect surfaces of mallets and form blocks for imbedded foreign objects which would scratch surface of material, see figure 1 for minimum bend radii for various materials.

e. When several bending operations are performed on the part, the part must be laid out accurately (WP004 00).

4. FORMING LIMITS. During forming of materials a small amount of material creep and deformation will occur. Limits for different formed shapes and forming operations are shown in figure 2.

5. HAND FORMING. Hand forming, like machine forming, includes stretching or shrinking of material. Several methods may be used depending on size, form, and contour of part.

a. **Straight Line Bends.** Short straight line bends may be made with wooden or metal bending blocks. After a part has been laid out and cut to size, clamp it rigidly between two forming blocks as shown in figure 3. Forming blocks have one edge rounded to give desired bend radius. By striking lightly with a rubber, plastic, or rawhide mallet, bend metal protruding beyond bending block to required angle. Start striking at one end, and work back and forth along edge, making bend gradually and evenly. Continue this process until protruding metal is bent to required angle. If a large amount of metal extends past bending blocks, maintain enough hand pressure against protruding sheet to prevent metal from bouncing. Remove any irregularity in flange by holding a straight block of hardwood edgewise against bend and striking it with heavy blows of a mallet. If amount of metal protruding beyond bending blocks is small, make whole bend by using hardwood block and mallet.

b. **Curved Flanged Parts.** Curved flanged parts have mold lines either concave or convex. The concave flange is formed by stretching while the convex flange is formed by shrinking. Such parts are shaped with the aid of hardwood or metal form blocks. These blocks are made in pairs and specifically for shape of part being formed. Each pair fits accurately and conforms to true dimension and contour of finished part. Mating blocks may be

equipped with small aligning pins to aid in alignment of blocks and to hold material in place. The blocks may be held together by C-clamps or a vise. Edges of form blocks are rounded to give correct radius of bend to part and are undercut, about five degrees, to allow for spring back of metal. This undercut is specially important if material is hard, or if bend must be highly accurate. To accurately lay out and cut form blocks to correct size when only mold line dimensions of part are known, correction chart shown in figure 4 must be used for locating edge of form block. The chart gives correction "C" which is the amount to be subtracted from mold line dimension of part to be formed. This corrected measurement is size to which form block shall be cut. Major steps in forming a curved flange are shown in figure 3. Cut material to size, allowing about one-quarter inch excess material or trim, and drill holes for alignment pins. File and sand edges of material to remove all nicks caused by cutting tools. This reduces possibility of material cracking at edges during forming operation. Position material between form blocks and clamp tightly in a vise so material will not move or shift. Clamp work as closely as possible to area being formed to prevent strain on form block and to keep material from slipping.

c. **Concave Surfaces.** Concave surfaces are formed by stretching material over a form block, see figure 5. Using a plastic or rawhide mallet with a smooth, slightly rounded face, start striking at extreme ends of the part, and continue toward center of bend. This procedure allows some material at ends of part to be worked into center of curve where it will be needed. Continue striking until metal is gradually worked down over entire flange and flush with form block. After flange is formed, trim off excess material and inspect part for accuracy.

d. **Convex Surfaces.** Convex surfaces are formed by shrinking material over a form block, see figure 6. Use a wooden or plastic shrinking mallet and a backup or wedge block, start at center of curve and work towards both ends. Work flange down over form striking metal with glancing blows at an angle of approximately 45 degrees, and with a motion that will tend to pull part away from radius of form block. While working metal down over form block, wedge block is used to keep edge of flange as nearly perpendicular to form block as possible. Wedge block also lessens possibility of buckles, and of splitting or cracking metal. Another method of hand

forming flanges is by using a lead bar or strap. Material, while secured in form block, is struck by lead strap which takes shape of part being formed and forces it down against form block. One advantage in using this method is metal is formed without marring or wrinkling and is not thinned out as much as it would be by other methods of hand forming. After flange is formed, trim off excess material and inspect part for accuracy.

e. Extruded Angles. Extruded angles can be curved, but not bent sharply, by stretching or shrinking one of the flanges. In this forming process, position flange to be stretched in groove of a V block as shown in figure 7, or if flange is to be shrunk, position flange across V block. Using a stretching mallet, strike flange directly over V portion with light, even blows and slowly force it down into V cutout. Too heavy a blow will buckle angle strip. Keep moving angle strip across V block but always strike spot directly across V. Form curve slowly and evenly by moving strip slowly back and forth; spreading mallet blows at equal spaces on flange. Lay out a full sized, accurate pattern on a sheet of paper and at intervals inspect accuracy of curve. By comparing part with pattern, you can tell how accurately curve is progressing and just where it needs to be increased or decreased. Form part roughly to required shape before trying to finish any one section because finishing or smoothing of angle may cause some other part of angle to change shape. If any area of part is curved excessively, reduce curve by reversing part on V block, and striking it light blows with a mallet. Try to form curve with minimum amount of blows for excessive blows will work-harden metal. Work-hardening can be recognized by a lack of bending or resilience in metal. In some cases part may have to be annealed before forming operation can continue.

f. Joggling. A joggle is an offset formed on a part to allow clearance for a sheet or another mating part. There are a number of different methods for forming joggles. Form joggle as below:

(1) Lay out boundary lines where bends are to occur on part.

(2) If joggle is on flat metal, form on cornice brake, refer to paragraph 6,c.(1) thru (6).

(3) On parts with curved flanges or wide webs, a joggle is formed on a form block as shown in figure 8.

(4) Straight and narrow parts such as extrusions or brake formed angles may be joggled with blocks or dies, as described in sub step g. below.

g. Dies and Joggle Blocks. When making dies, dimensions for joggles shall be as shown in figure 9. If dies are to be used only a few times, hardwood is satisfactory as it is easily worked. If a number of similar joggles are to be produced, then use a steel or aluminum alloy die. Dies made of aluminum alloy are preferred, since they are easier to fabricate than those of steel and will wear about as long. When using joggle blocks for first time, test them for accuracy on a piece of waste stock. In this way possibility of ruining already fabricated parts can be avoided. Always keep surfaces of blocks free from dirt and filings so work will not be marred or cracked. On small parts or parts having relatively short width joggle, fastest and easiest method of forming joggle is by using a joggling clip as shown in figure 10. The joggle clip can be made easily and quickly for any size joggle required. For best results, make the joggle clips from material that is as hard as, or harder than, the material being joggled and one gage thicker than required depth of finished joggle. Width of slot to be cut in clip shall be dimension taken from figure 10 minus thickness of joggling clip. After cutting slot, round edges and sand or file smooth. The procedure for using joggling clip is to first lay out bend lines of joggle on part to be formed. Insert part into joggling clip and clamp clip and material in vise or holding device.

NOTE

Jaws of the vise used for clamping clips and material shall be machined smooth or covered with soft-metal, such as brass to prevent scratching material during forming operation.

h. Forming Joggles. Form a joggle by placing part to be joggled between two joggle blocks and squeezing in a vise or some other suitable clamping device. As joggle is formed, bulge on flange is flattened with wooden or rawhide mallet.

i. Inspection. After forming the part, visually inspect the joggle for cracks and proper dimensions, before installing on aircraft. When using joggle clip for the first time, inspect for accuracy on piece of scrap material.

6. **MACHINE FORMING.** Two types of forming machines are brakes and slip roll formers.

a. Cornice Brake. The most accurate method of making straight line bends on piece of sheet metal is by box pan or cornice brake, see figure 11.

NOTE

Before bending any work demanding an accurate bend radius and definite leg length, setting of brake should be inspected with piece of scrap metal.

b. When making an ordinary bend on a brake;

(1) Position sheet to be bent on brake so bend line is directly under edge of upper jaw or clamping bar.

(2) Pull down clamping bar handle. This brings clamping bar down to hold sheet firmly in place.

(3) Set stop for correct angle or amount of bend, and make bend by raising bending leaf until it strikes stop.

(4) If more than one bend is to be made, bring next bend line under clamping bar and repeat bending procedure.

c. To form a joggle;

(1) Lay out boundary lines of joggle where bends are to occur on sheet.

(2) Insert sheet in brake and bend metal up about twenty to thirty degrees, see figure 8.

(3) Release brake and remove part.

(4) Turn part over and clamp in brake at second bend line.

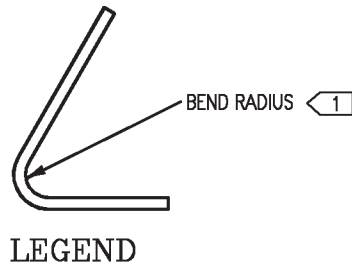
(5) Bend part up to correct height of joggle.

(6) Remove part from brake and inspect joggle for correct dimensions and clearance.

NOTE

Before inserting material rolls, inspect surface of rolls and remove all dirt or sharp protruding nicks and gouges. Any dirt or sharp protruding points left on surface of roll will be imbedded into surface of material as it passes through rolls. Parts damaged in such manner shall not be installed on aircraft.

d. Slip Roll Former. The slip roll former is used to form sheet material into cylinders, cones, or other curved surfaces with straight line elements, see figure 12. The slip roll former is made up of right and left end frames with three solid steel rolls mounted between. The two gripping rolls are connected by gears operated by either hand crank or power drive. These rolls can be adjusted to metal thickness by two adjusting screws located on bottom of each frame. When metal is started into machine, rolls grip it and carry it to rear roll which curves it. Adjust rear roll to get correct radius of bend. The bend radius of part can be inspected as forming operation progresses by using a circle board, or radius gage. Gages can be made by cutting material to required finished radius and comparing it to radius being formed by rolling operation. On some material, forming operation must be performed by passing material through rolls several times with progressive settings on forming roll. The rear and lower front rolls are grooved on one end. These grooves are for forming wires or for forming parts with wired edges on outside of curve. On most machines, top roll can be released on one end allowing formed sheet to be removed from machine without distortion.



1 BEND RADII ARE MEASURED ON INSIDE SURFACE OF BEND.

TOLERANCES FOR FORMED PARTS

BEND RADIUS	TOLERANCE
0.03 TO 0.06	+ 0.03-0.00
0.07 TO 0.25	± 0.03
0.26 TO 0.50	± 0.06
0.51 TO 1.00	± 0.09
1.01 TO 2.00	± 0.13
2.01 TO 3.00	± 0.19
3.01 TO 5.00	± 0.25

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MATERIAL THICKNESS	ALUMINUM					
	2024-O 1	5052-H34	2024-T3 2	2024-T81	7075-O 4	7075-T76
	5052-O	6061-T6	2024-T351 2	2024-T851 2024-T6	5052-H32	7075-T6
	6061-O		2024-T4 3	2024-T72 2024-T76		
	ROOM TEMP	ROOM TEMP	ROOM TEMP	ROOM TEMP	ROOM TEMP	ROOM TEMP
0.010						
0.012	0.03	0.06	0.06	0.06	0.03 1	0.06
0.016	0.03	0.06	0.06	0.09	0.03 1	0.06
0.020	0.03	0.06	0.06	0.13	0.06	0.09
0.025	0.06	0.09	0.09	0.16	0.06	0.13
0.028						
0.032	0.06	0.13	0.13	0.19	0.06	0.16
0.036						
0.040	0.06	0.13	0.13	0.25	0.09	0.22
0.045						
0.050	0.09	0.16	0.16	0.31	0.13	0.25
0.056						
0.063	0.13	0.22	0.22	0.38	0.13	0.31
0.071	0.13	0.25	0.25	0.44	0.16	0.38
0.080	0.13	0.28	0.28	0.50	0.19	0.41
0.090	0.13	0.31	0.36	0.56	0.19	0.47
0.100	0.16	0.38	0.41	0.63	0.22	0.56
0.112						
0.125	0.19	0.44	0.50	0.88	0.28	0.69
0.140						
0.160	0.25	0.56	0.66	1.00	0.38	0.88
0.180						
0.190	0.31	0.75	0.81	1.31	0.44	1.13
0.200						
0.224						
0.250	0.50	1.00	1.13	2.00	0.63	1.50
0.313	0.63	1.25	1.50		0.81	2.00
0.375	0.75	1.50	1.88		1.00	2.50
0.500	1.00	2.00	2.50		1.50	325

LEGEND

1 AFTER FORMING, HEAT TO -T72.

2 AFTER FORMING, AGE TO -T81.

3 AFTER FORMING, AGE TO -T72.

4 AFTER FORMING, AGE TO -T6 (±0.080), -T76 (+0.080)

MATERIAL THICKNESS	TITANIUM	
	UN-ALLOYED	6AL-4V 1 6AL-4V-ELI 1 6AL-6V-2Sn 1
	ROOM TEMP	ROOM TEMP
0.010		
0.012	0.06	0.06
0.016	0.06	0.09
0.020	0.09	0.13
0.025	0.09	0.13
0.028	0.13	0.16
0.032	0.13	0.16
0.036	0.13	0.19
0.040	0.16	0.22
0.045	0.16	0.25
0.050	0.19	0.25
0.056	0.19	0.31
0.063	0.22	0.33
0.071	0.25	0.38
0.080	0.28	0.44
0.090	0.31	0.50
0.100	0.38	0.56
0.112	0.41	0.63
0.125	0.44	0.72
0.140	0.50	0.88
0.160	0.56	1.00
0.180	0.63	1.13
0.190	0.69	1.25
0.200		

LEGEND

1 SINGLE ANLD.

Figure 1. Minimum Bend Radius (Sheet 1)

MATERIAL THICKNESS	STAINLESS STEEL										ALLOY STEELS T-1		MATERIAL THICKNESS
	Ph 15-7 Mo		17-7Ph		301 ANLD. 302 ANLD. 304 ANLD. 316 ANLD. 321 ANLD. 347 ANLD.	301 (1/4H) 316 (1/4H)	301 (1/2H)	301 (3/4 H)	301 (H)	A-286 (SOL. TR.)	1010 THRU 1025 (COMM. STEELS) 1095 4130 4340 (ANLD. NORM.)	(LOW ALLOY EXTRA HIGH STRENGTH STEEL)	
	(COND. A ANLD)	(COND. TH1050)	(COND. A ANLD.	(COND. TH 1050)									
	ROOM TEMP		ROOM TEMP		ROOM TEMP	ROOM TEMP				ROOM TEMP	ROOM TEMP		
0.010													
0.012	0.03	0.12	0.03	0.13	0.03	0.06	0.06	0.09	0.09	0.03	0.03	0.06	0.12
0.016	0.03	0.12	0.03	0.13	0.03	0.06	0.06	0.09	0.09	0.03	0.03	0.06	0.16
0.020	0.03	0.12	0.06	0.16	0.03	0.06	0.06	0.09	0.12	0.03	0.06	0.09	0.20
0.025	0.03	0.16	0.06	0.16	0.03	0.06	0.09	0.12	0.16	0.03	0.06	0.09	0.25
0.028	0.03	0.25	0.06	0.25	0.03	0.06	0.09	0.16	0.16	0.03	0.06	0.13	0.28
0.032	0.03	0.25	0.06	0.25	0.03	0.06	0.09	0.16	0.19	0.03	0.06	0.13	0.32
0.036	0.06	0.25	0.09	0.25	0.06	0.09	0.13	0.19	0.22	0.06	0.09	0.13	0.36
0.040	0.06	0.25	0.09	0.31	0.06	0.09	0.13	0.19	0.22	0.06	0.09	0.16	0.40
0.045	0.06	0.28	0.09	0.34	0.06	0.09	0.13	0.22	0.22	0.06	0.09	0.16	0.45
0.050	0.06	0.31	0.13	0.38	0.06	0.13	0.16	0.22	0.22	0.06	0.13	0.16	0.50
0.056	0.06	0.34	0.13	0.47	0.06	0.13	0.19	0.25	0.25	0.06	0.13	0.19	0.56
0.063	0.09	0.38	0.13	0.50	0.06	0.13	0.19	0.25	0.25	0.06	0.13	0.22	0.63
0.071	0.09	0.44	0.16	0.56	0.09	0.16	0.22	0.28	0.28	0.09	0.16	0.25	0.71
0.080	0.12	0.50	0.16	0.63	0.09	0.16	0.25	0.31	0.31	0.09	0.16	0.28	0.80
0.090	0.16	0.56	0.19	0.75	0.09	0.19	0.31	0.38	0.38	0.09	0.19	0.31	0.90
0.100	0.19	0.62	0.22		0.13	0.22	0.31	0.47	0.47	0.13	0.22	0.34	0.100
0.112	0.19	0.75	0.22		0.13	0.22	0.34	0.47	0.47	0.13	0.22	0.38	0.112
0.125	0.22	0.75	0.25		0.13	0.25	0.38	0.50	0.50	0.13	0.25	0.41	0.125
0.140	0.22	0.86	0.28		0.16	0.28	0.44	0.50	0.50	0.16	0.28	0.47	0.140
0.160	0.25	1.00	0.34		0.16	0.31	0.50	0.50	0.50	0.16	0.31	0.56	0.160
0.180	0.28	1.12	0.38		0.19	0.38	0.56	0.69	0.69	0.19	0.36	0.63	0.180
0.190	0.34	1.25	0.38		0.19	0.38	0.63	0.75	0.75	0.19	0.36	0.63	0.190
0.200	0.44	1.25			0.22	0.41	0.63	0.88	0.88	0.22	0.41	0.69	0.200
0.224	0.47	1.38			0.22	0.44	0.69	0.88	0.88	0.22	0.44	0.75	0.224
0.250	0.50	1.50			0.25	0.50	0.75	1.00	1.00	0.25	0.50	0.98	0.250
0.315					0.31						0.63	1.25	0.313
0.375					0.38						0.75	1.50	0.375
0.500					0.50						1.00	2.00	0.500

Figure 1. Minimum Bend Radius (Sheet 2)

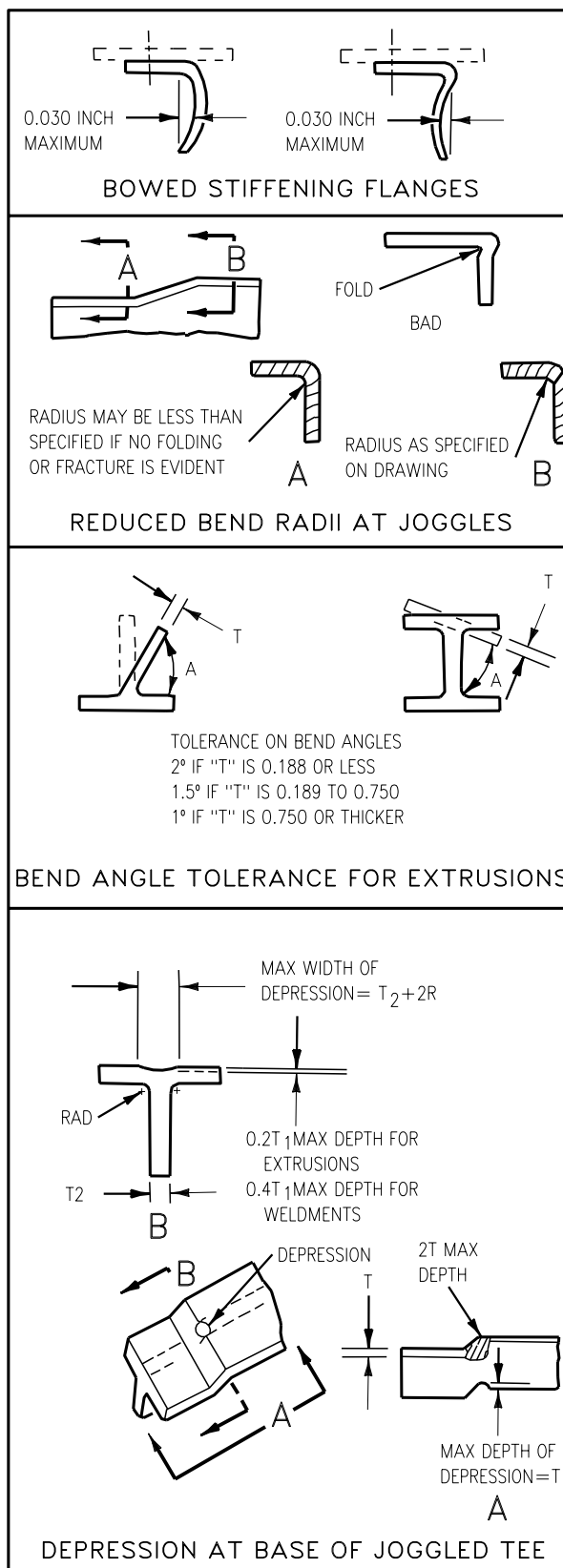
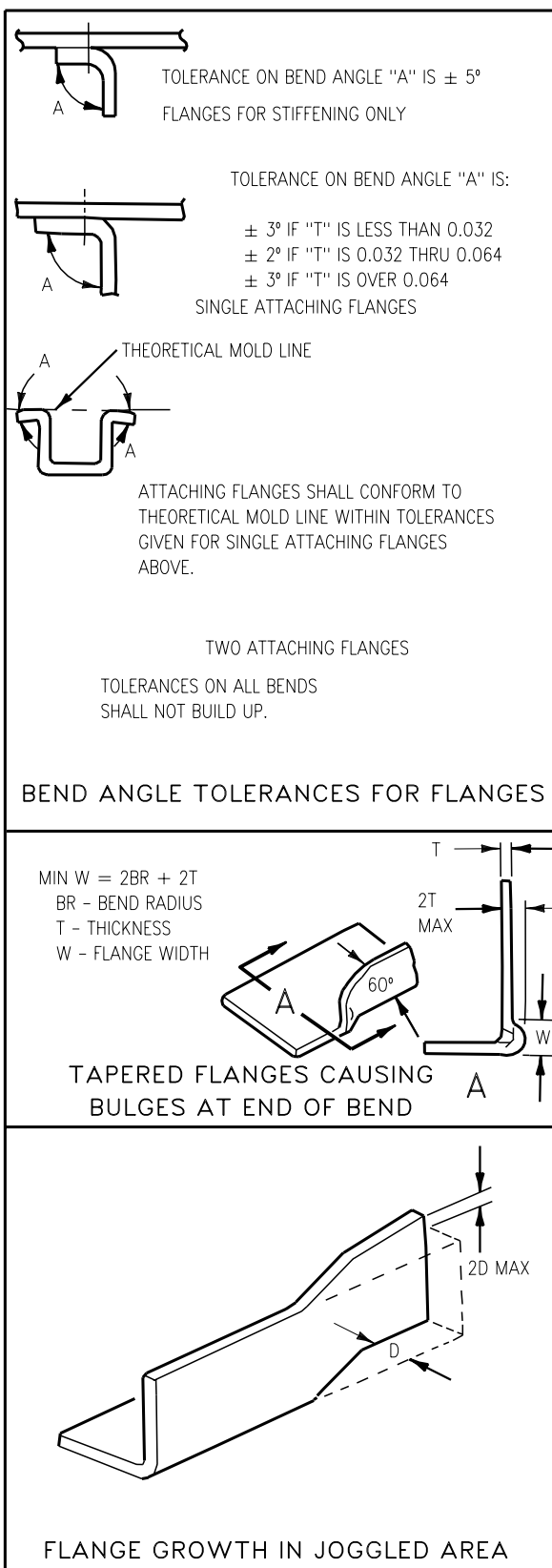


Figure 2. Sheet Metal Inspection Requirements (Sheet 1)

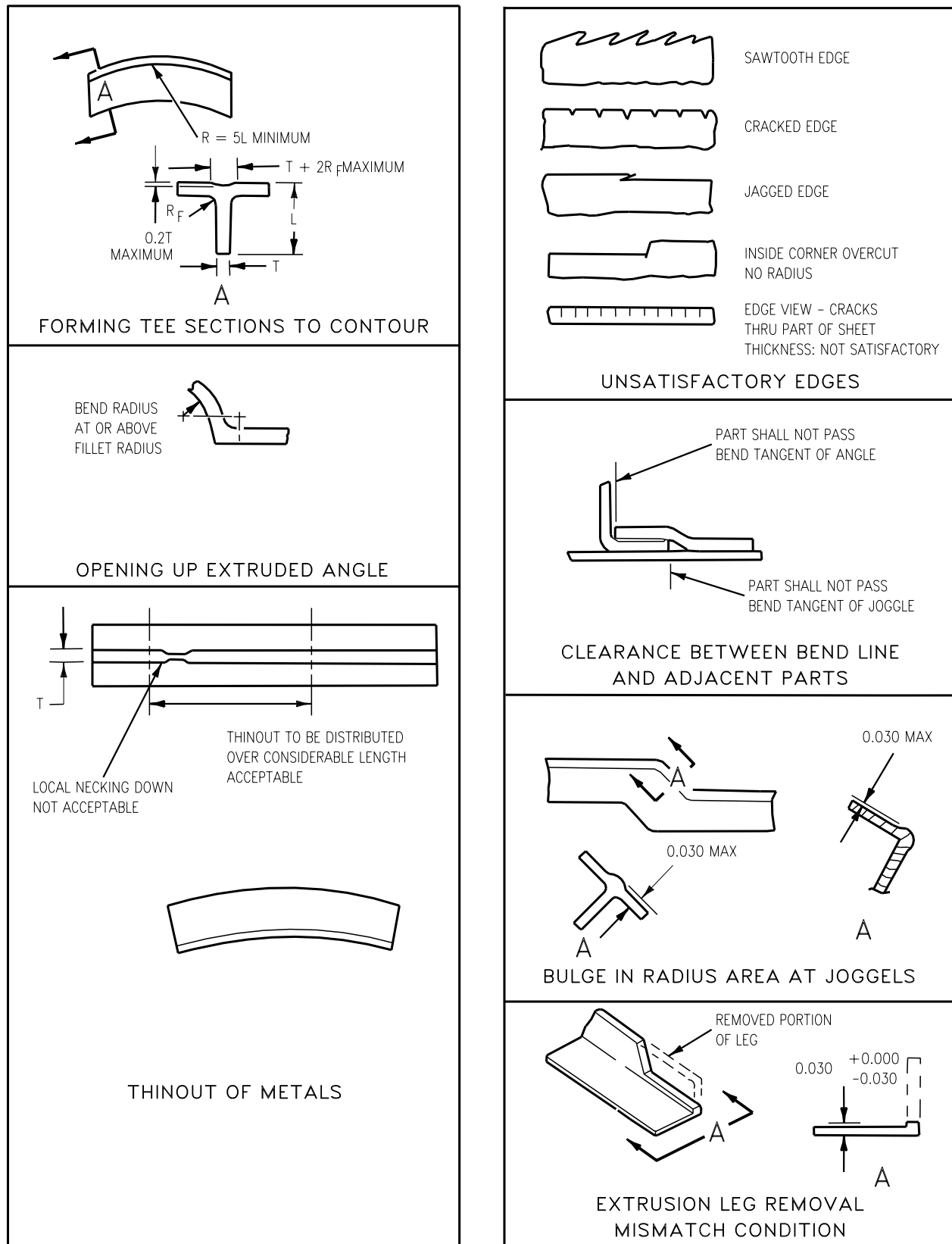


Figure 2. Sheet Metal Inspection Requirements (Sheet 2)

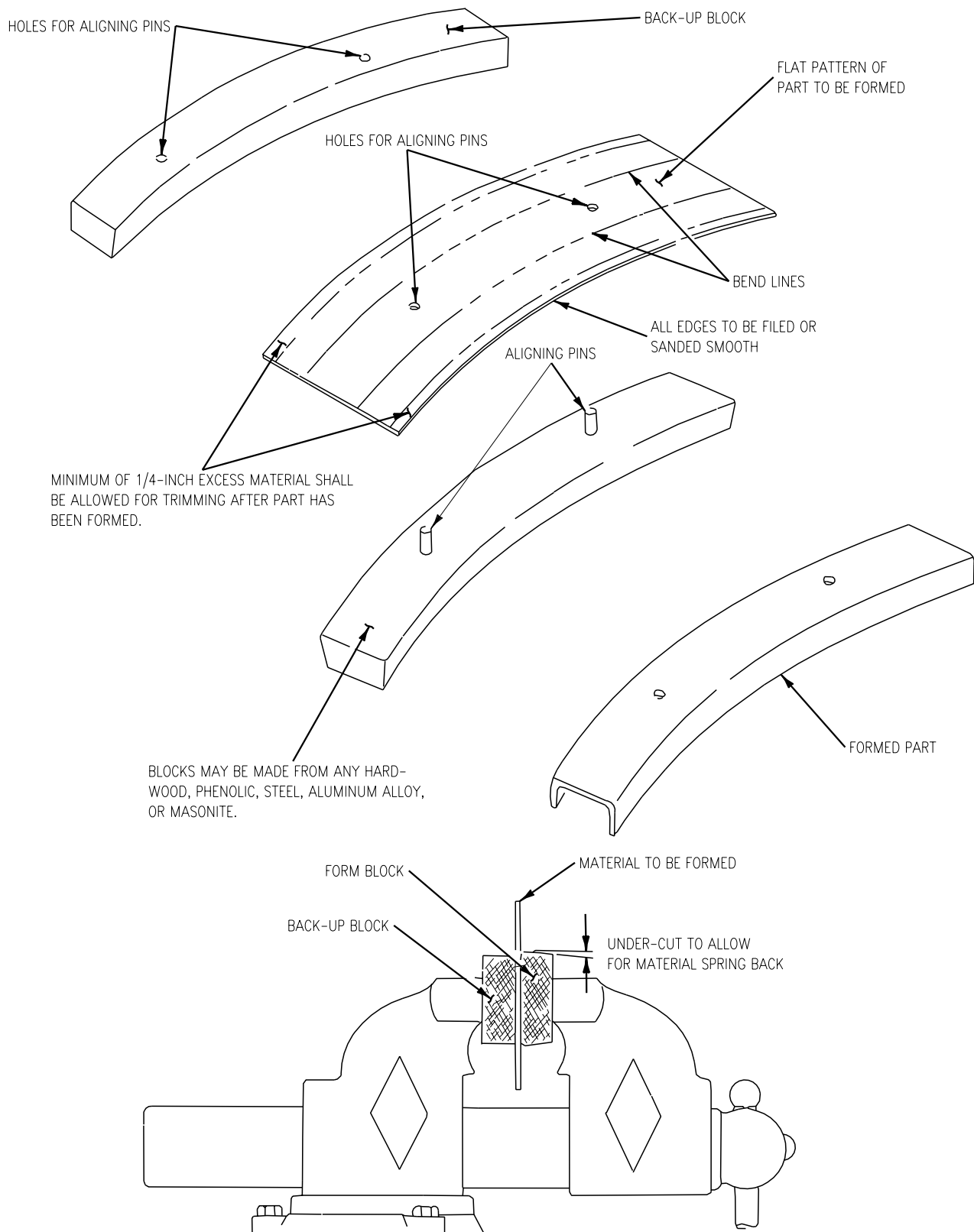
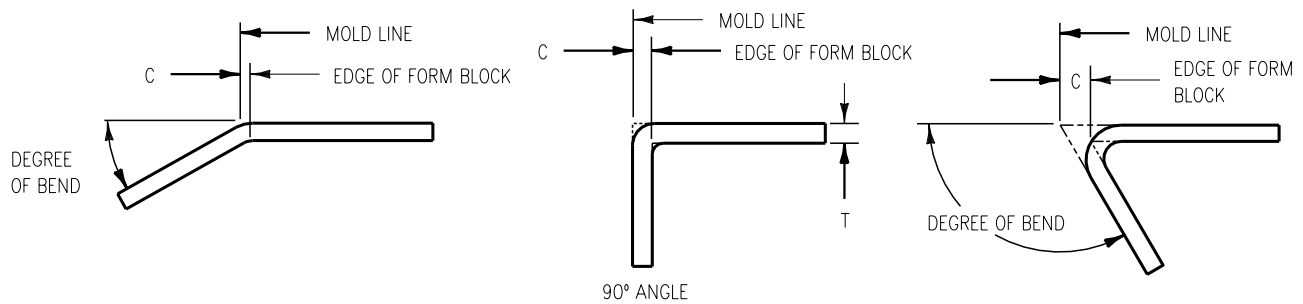


Figure 3. Material and Form Block Alignment

THE CHART ILLUSTRATES ALLOWANCE TO BE MADE FROM MOLD LINE TO THEORETICAL EDGE OF FORM BLOCK OR EDGE OF UPPER JAW ON CORNICE BRAKE.



(FOR 90° BEND, "C" IS ALWAYS EQUAL TO MATERIAL THICKNESS)

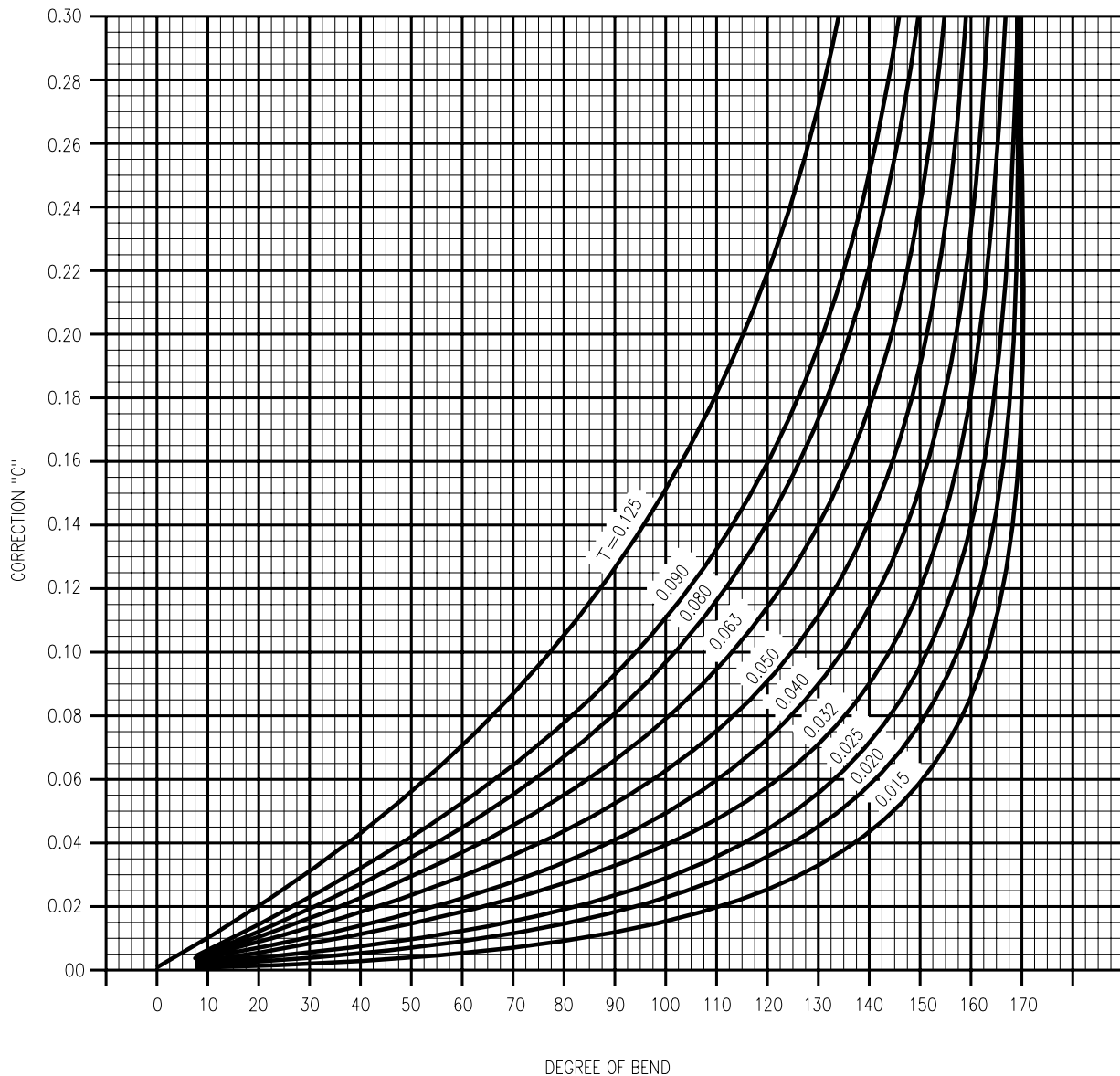


Figure 4. Form Block and Cornice Brake Correction Allowance

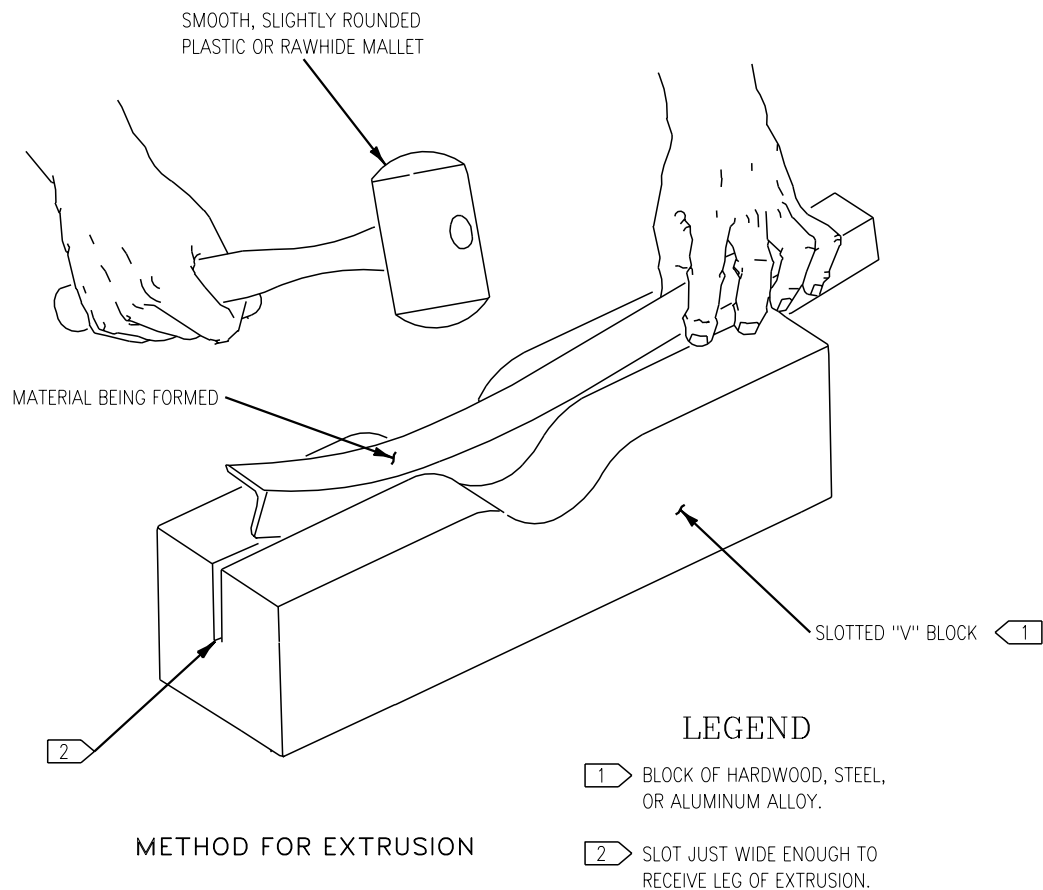
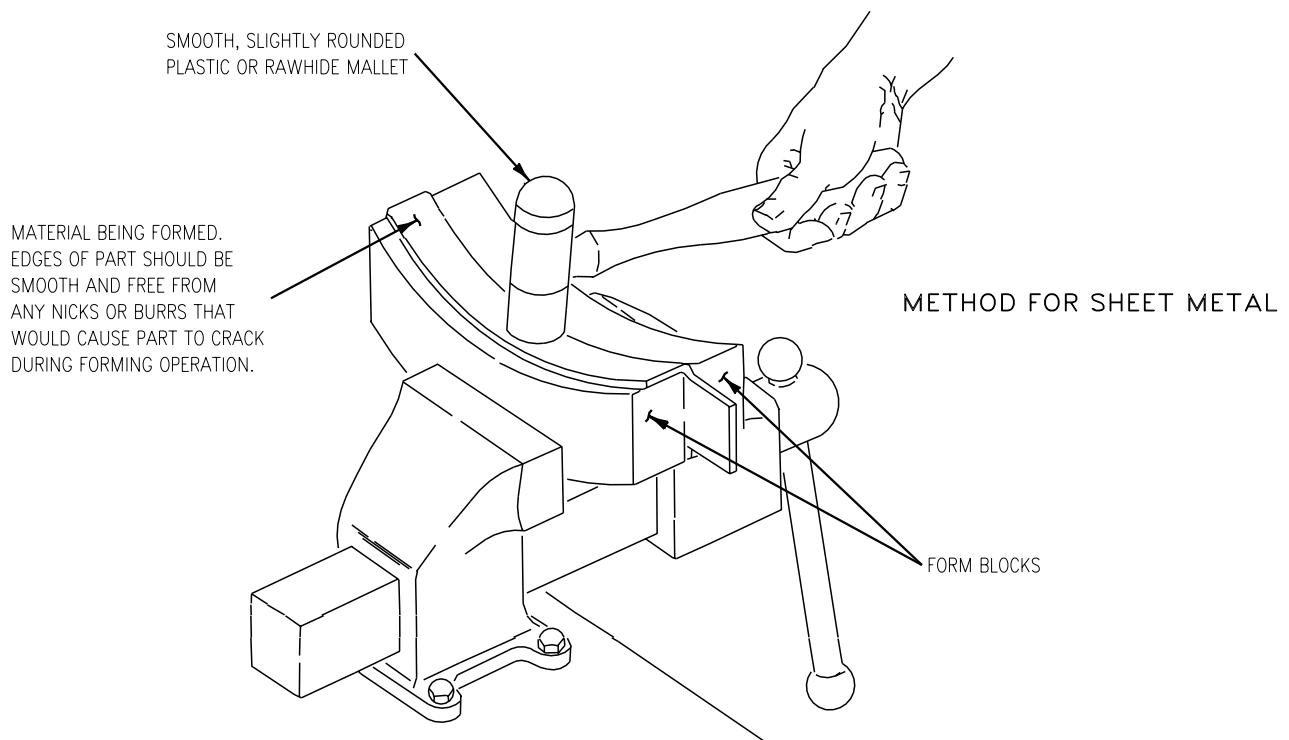
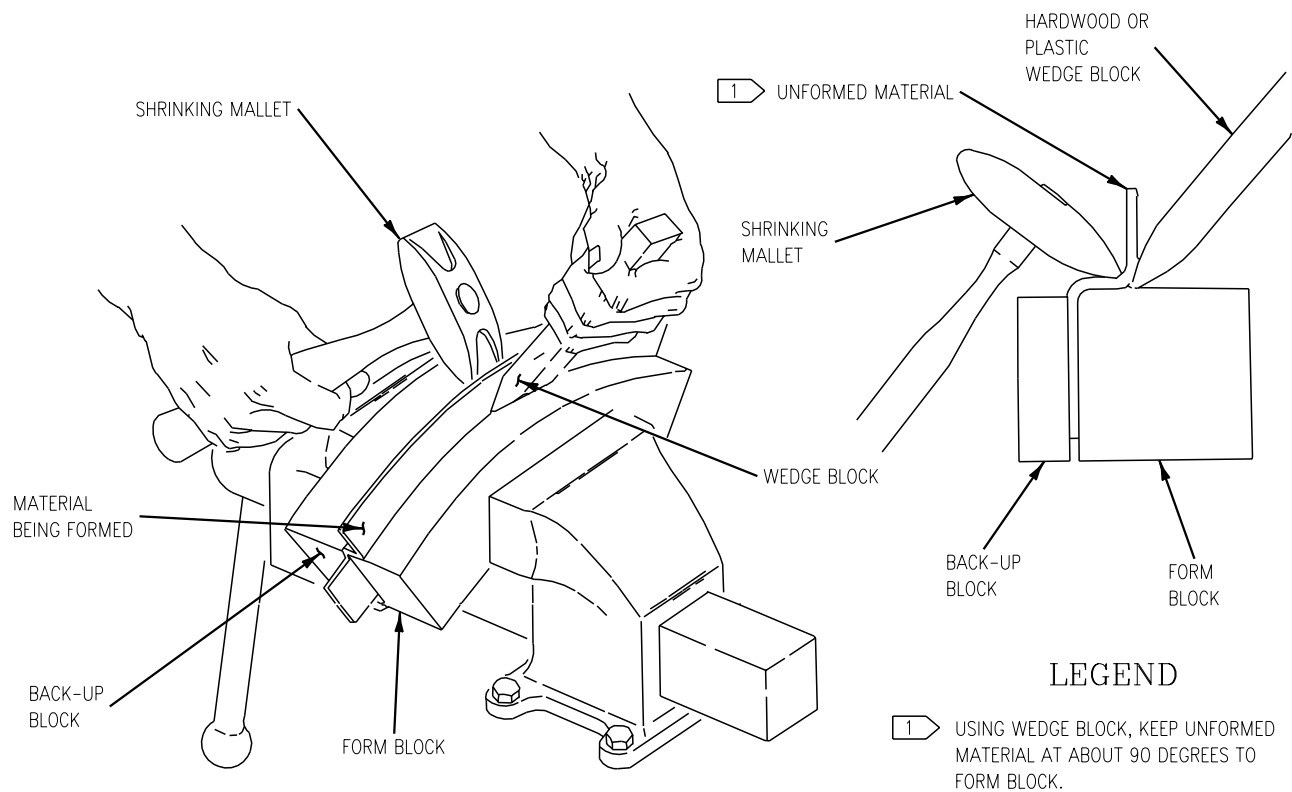
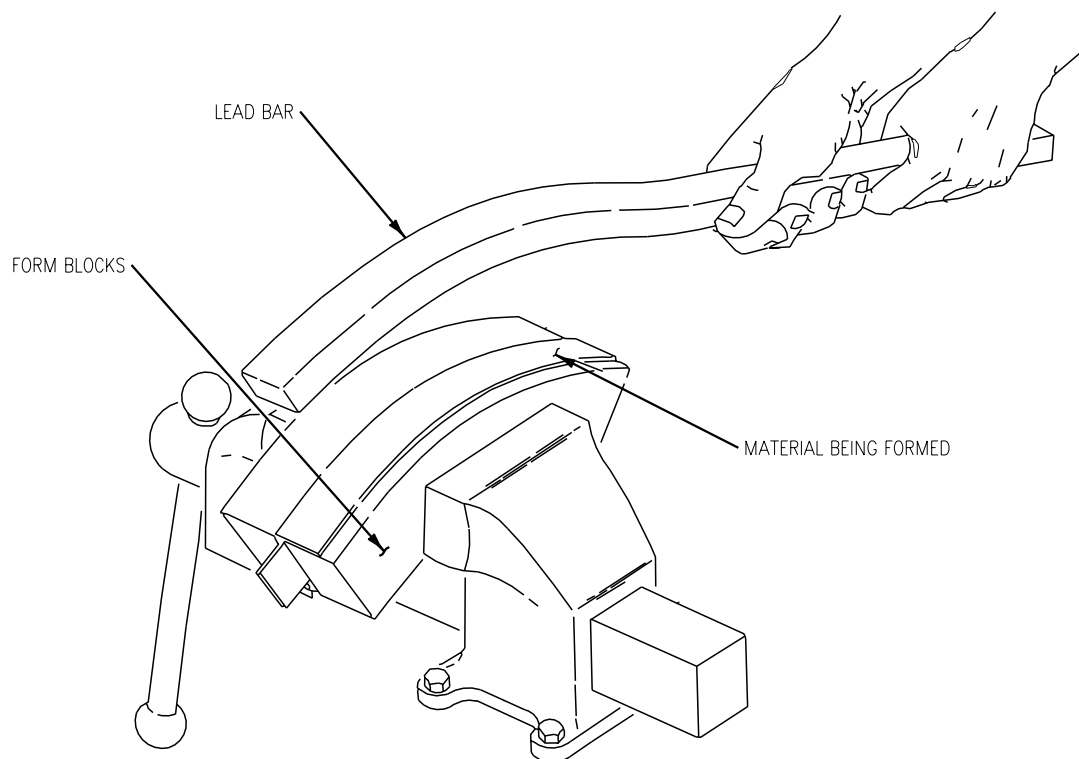


Figure 5. Hand Forming Concave Surfaces



METHOD "A"



METHOD "B"

Figure 6. Hand Forming Convex Surfaces

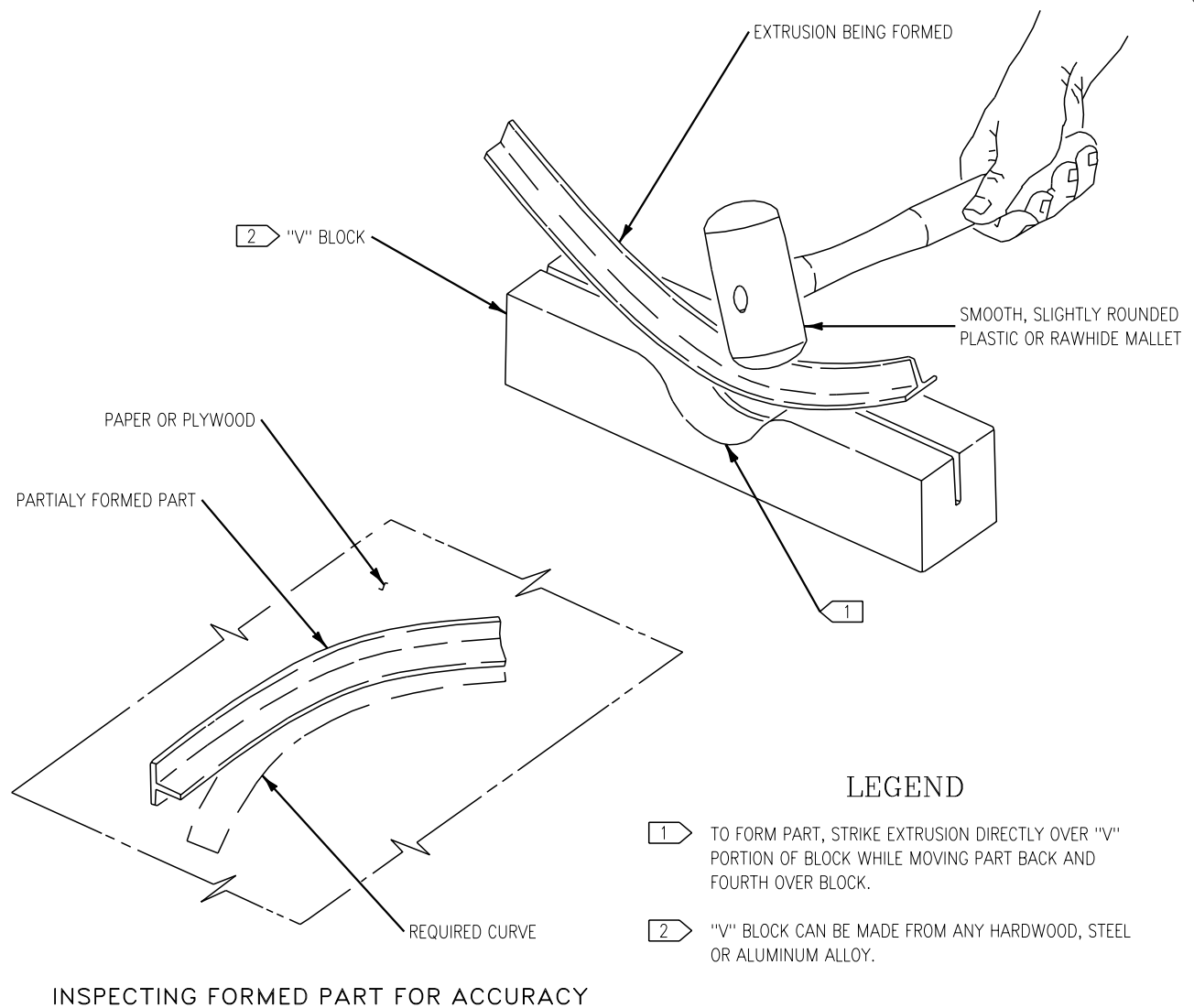
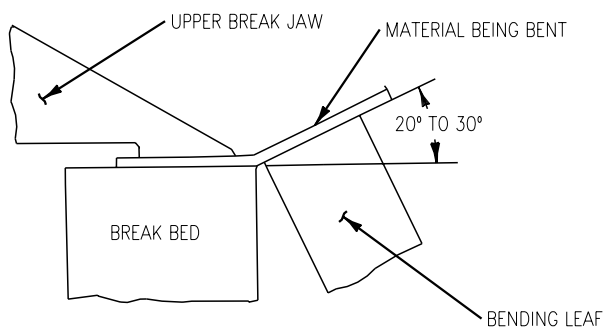
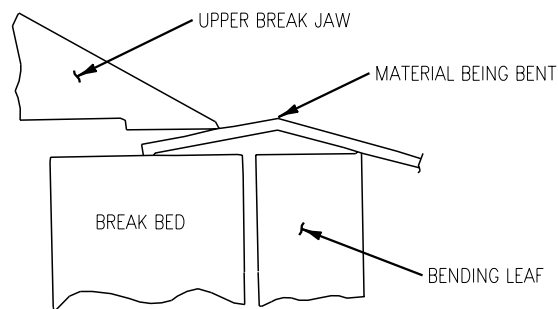


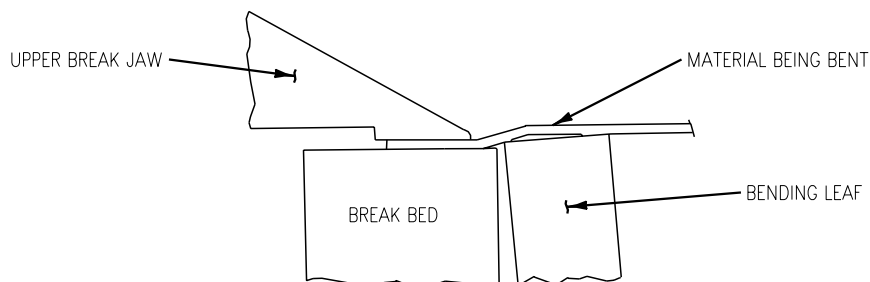
Figure 7. Hand Forming Extruded Shapes



STEP 1 CLAMP MATERIAL IN BREAK AND BEND UP 20 TO 30 DEGREES.

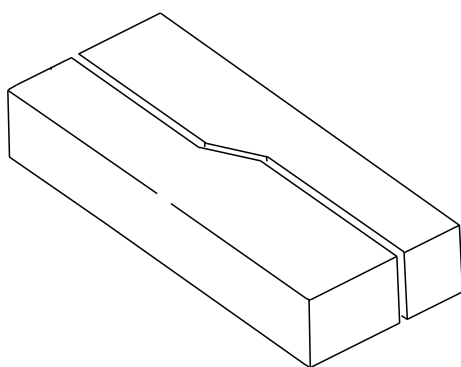


STEP 2 TURN MATERIAL OVER AND CLAMP IN BREAK.

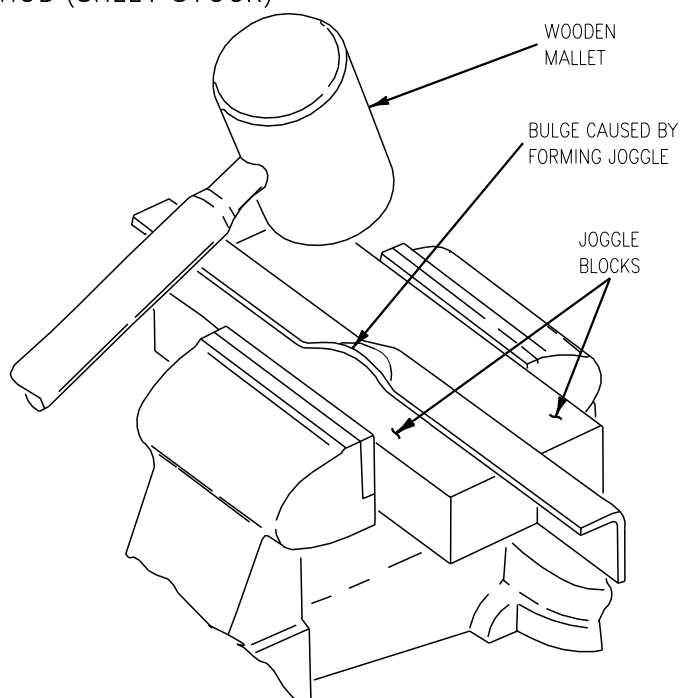


STEP 3 RAISE BENDING LEAF OF BRAKE UNTIL CORRECT OFFSET IS PRODUCED.

BRAKE METHOD (SHEET STOCK)



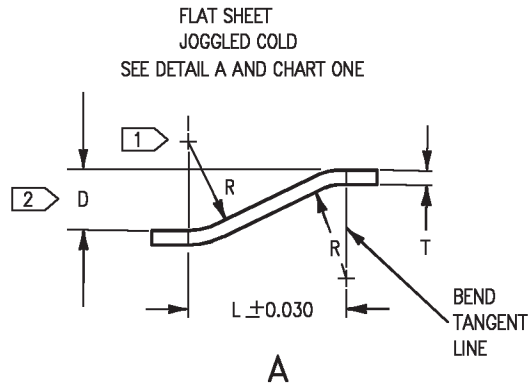
METAL OR HARDWOOD BLOCKS, BEFORE INSERTION OF ANGLE TO BE JOGGLED.



SQUEEZE ANGLE BETWEEN BLOCKS, FLATTENING BULGE WITH WOODEN, PLASTIC, OR RAWHIDE MALLET AS JOGGLE PROGRESSES.

JOGGLE BLOCK METHOD

Figure 8. Forming Joggles Using Brake or Joggle Blocks



MATERIAL	USE COLUMN
2024-0	A
2024-T3	A
6061-0	A
6061-T6	A
7075-0	A
7075-T6	B
TITANIUM	B
STAINLESS STEEL HARD	B
STAINLESS STEEL ANNEALED	A
ALLOY STEEL ANNEALED	A
INCONEL	B

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CHART 1

DEPTH OF OFFSET "D"	JOGGLE LENGTH "L"													
	WHEN SHEET THICKNESS "T" IS:													
	UP THRU 0.022		0.023 THRU 0.027		0.028 THRU 0.035		0.036 THRU 0.044		0.045 THRU 0.054		0.055 THRU 0.068		0.069 THRU 0.075	
UP THRU 0.022	A	B	A	B	A	B	A	B	A	B	A	B	A	B
0.032 THRU 0.027	0.14	0.17	0.16	0.18	0.17	0.19	0.18	0.21	0.19	0.22	0.21	0.24	0.22	0.24
0.028 THRU 0.035	0.15	0.18	0.17	0.19	0.19	0.19	0.19	0.22	0.21	0.24	0.23	0.25	0.24	0.27
0.036 THRU 0.044	0.16	0.19	0.18	0.20	0.20	0.20	0.20	0.24	0.22	0.26	0.25	0.28	0.26	0.29
0.045 THRU 0.054	0.17	0.20	0.20	0.22	0.22	0.23	0.22	0.26	0.24	0.28	0.27	0.30	0.28	0.32
0.055 THRU 0.068	0.20	0.21	0.21	0.23	0.24	0.25	0.24	0.28	0.26	0.31	0.29	0.33	0.31	0.35
0.069 THRU 0.075	0.21	0.24	0.24	0.25	0.25	0.27	0.25	0.30	0.28	0.33	0.32	0.36	0.34	0.38
0.076 THRU 0.084	0.22	0.25	0.25	0.26	0.26	0.28	0.26	0.32	0.29	0.34	0.33	0.38	0.35	0.41
0.085 THRU 0.097	0.22	0.26	0.26	0.29	0.27	0.29	0.27	0.33	0.30	0.36	0.33	0.40	0.37	0.42
0.098 THRU 0.113	0.23	0.26	0.27	0.29	0.30	0.30	0.30	0.35	0.31	0.38	0.38	0.41	0.38	0.44
0.114 THRU 0.139	0.23	0.27	0.27	0.30	0.31	0.34	0.31	0.36	0.32	0.39	0.37	0.43	0.39	0.46
0.140 THRU 0.172	0.24	0.28	0.29	0.32	0.33	0.36	0.33	0.39	0.37	0.42	0.40	0.47	0.43	0.50
0.173 THRU 0.219	0.24	0.30	0.30	0.34	0.35	0.38	0.35	0.45	0.39	0.46	0.46	0.51	0.47	0.55
0.220 THRU 0.262	0.24	0.30	0.31	0.35	0.36	0.40	0.36	0.47	0.41	0.51	0.48	0.54	0.52	0.59
	0.24	0.30	0.31	0.37	0.37	0.43	0.38	0.51	0.44	0.56	0.53	0.62	0.57	0.68

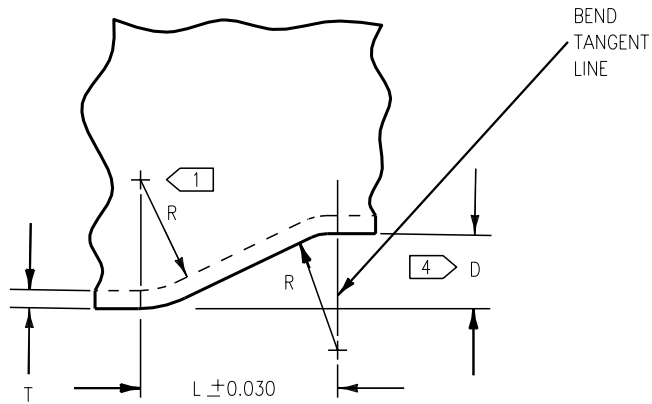
CHART 1 (CONT.)

DEPTH OF OFFSET "D"	JOGGLE LENGTH "L"													
	WHEN SHEET THICKNESS "T" IS:													
	0.076 THRU 0.084		0.085 THRU 0.097		0.098 THRU 0.113		0.114 THRU 0.139		0.140 THRU 0.172		0.173 THRU 0.219		0.220 THRU 0.262	
UP THRU 0.022	A	B	A	B	A	B	A	B	A	B	A	B	A	B
0.023 THRU 0.027	0.23	0.27	0.24	0.28	0.26	0.29	0.27	0.32	0.30	0.34	0.34	0.38	0.37	0.38
0.028 THRU 0.035	0.25	0.29	0.26	0.30	0.28	0.31	0.29	0.35	0.34	0.38	0.37	0.41	0.41	0.43
0.036 THRU 0.044	0.27	0.31	0.29	0.33	0.30	0.35	0.32	0.38	0.37	0.42	0.41	0.46	0.44	0.49
0.045 THRU 0.054	0.30	0.34	0.31	0.36	0.33	0.38	0.36	0.42	0.40	0.46	0.45	0.50	0.49	0.51
0.055 THRU 0.068	0.33	0.37	0.34	0.39	0.37	0.41	0.39	0.46	0.44	0.50	0.49	0.56	0.54	0.61
0.069 THRU 0.075	0.35	0.40	0.37	0.43	0.40	0.45	0.43	0.51	0.47	0.55	0.54	0.61	0.58	0.68
0.076 THRU 0.084	0.37	0.42	0.39	0.45	0.43	0.47	0.45	0.53	0.50	0.59	0.57	0.65	0.62	0.72
0.085 THRU 0.097	0.38	0.44	0.41	0.47	0.44	0.50	0.47	0.56	0.53	0.62	0.60	0.69	0.66	0.77
0.098 THRU 0.113	0.40	0.47	0.42	0.50	0.46	0.52	0.48	0.59	0.55	0.65	0.63	0.72	0.69	0.80
0.114 THRU 0.139	0.42	0.49	0.44	0.52	0.48	0.55	0.51	0.62	0.58	0.69	0.66	0.75	0.72	0.85
0.140 THRU 0.172	0.45	0.53	0.48	0.56	0.51	0.59	0.55	0.68	0.63	0.75	0.71	0.82	0.79	0.94
0.173 THRU 0.219	0.51	0.58	0.53	0.62	0.57	0.65	0.62	0.74	0.69	0.82	0.79	0.91	0.87	1.03
0.220 THRU 0.262	0.53	0.62	0.56	0.66	0.61	0.70	0.56	0.80	0.71	0.89	0.85	0.99	0.94	1.12
	0.60	0.69	0.64	0.74	0.70	0.79	0.76	0.90	0.84	1.01	0.96	1.12	1.07	1.29

Figure 9. Joggle Dimensions (Sheet 1)

FLANGED SHEET

RUBBER FORMED AND JOGGLED COLD
SEE DETAIL B AND CHART TWO



B

APPLICABLE MATERIALS

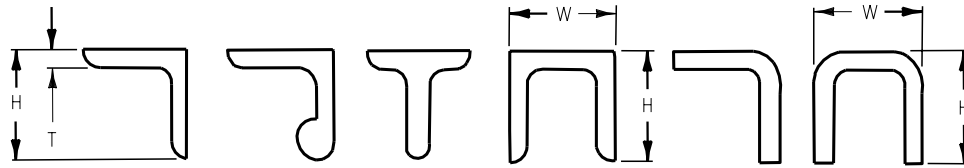
2024-0 6
2024-T3 6
6061-0
6061-T6
7075-0 6
STAINLESS STEEL ANNEALED
ALLOY STEEL ANNEALED

18AC-SRM-20-(23-2)31-CATI

CHART 2

DEPTH OF OFFSET "D"	JOGGLE LENGTH "L"													
	WHEN SHEET THICKNESS "T" IS:													
	UP THRU 0.022	0.023 THRU 0.027	0.028 THRU 0.035	0.036 THRU 0.044	0.045 THRU 0.054	0.055 THRU 0.068	0.069 THRU 0.075	0.076 THRU 0.084	0.085 THRU 0.097	0.098 THRU 0.113	0.114 THRU 0.139	0.140 THRU 0.172	0.173 THRU 0.219	0.220 THRU 0.262
UP THRU 0.022	0.12	0.13	0.15	0.15	0.15	0.18	0.19	0.20	0.21	0.23	0.24	0.27	0.31	0.34
0.023 THRU 0.027	0.14	0.15	0.16	0.16	0.17	0.20	0.21	0.22	0.23	0.25	0.26	0.31	0.34	0.38
0.028 THRU 0.035	0.15	0.17	0.18	0.18	0.19	0.22	0.23	0.24	0.26	0.27	0.29	0.34	0.38	0.41
0.036 THRU 0.044	0.18	0.19	0.20	0.20	0.21	0.24	0.25	0.27	0.28	0.30	0.33	0.37	0.42	0.46
0.045 THRU 0.054	0.21	0.22	0.23	0.23	0.25	0.27	0.28	0.30	0.31	0.34	0.36	0.41	0.46	0.51
0.055 THRU 0.068	0.24	0.25	0.27	0.27	0.28	0.31	0.32	0.33	0.35	0.37	0.40	0.44	0.51	0.55
0.059 THRU 0.075	0.26	0.27	0.29	0.29	0.30	0.33	0.34	0.35	0.37	0.39	0.42	0.47	0.54	0.59
0.076 THRU 0.084	0.29	0.30	0.32	0.32	0.33	0.35	0.37	0.38	0.39	0.42	0.44	0.50	0.57	0.63
0.085 THRU 0.097	0.32	0.33	0.34	0.34	0.36	0.38	0.39	0.41	0.42	0.44	0.47	0.52	0.60	0.66
0.098 THRU 0.113	0.35	0.36	0.37	0.37	0.39	0.41	0.42	0.44	0.45	0.47	0.50	0.56	0.63	0.69
0.114 THRU 0.139	0.41	0.42	0.44	0.44	0.45	0.47	0.49	0.50	0.51	0.54	0.56	0.62	0.69	0.76
0.140 THRU 0.172	0.51	0.52	0.53	0.53	0.55	0.57	0.59	0.60	0.61	0.64	0.66	0.71	0.78	0.85
0.173 THRU 0.219	0.60	0.61	0.62	0.62	0.64	0.66	0.68	0.69	0.70	0.73	0.75	0.80	0.86	0.94
0.220 THRU 0.262	0.77	0.78	0.79	0.79	0.81	0.83	0.85	0.86	0.87	0.90	0.92	0.97	1.04	1.11

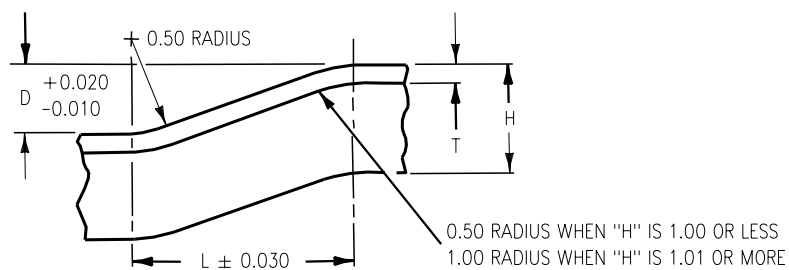
Figure 9. Joggle Dimensions (Sheet 2)



EXTRUDED OR BENT SECTIONS

SEE DETAIL C AND CHART THREE

CHART IS BASED ON ABOVE ILLUSTRATED COMMONLY USED SHAPES, HOWEVER, IT MAY BE SPECIFIED FOR VARIATIONS OF THESE SHAPES PROVIDED JOGGLE DIMENSIONS ARE BASED ON SAME PROPORTIONS OF "H" TO "T" AS SHOWN HEREON. DO NOT SPECIFY FOR CHANNELS WHERE "W" IS LESS THAN "2H". WHERE A SECTION HAS WEBS OR FLANGES OF A DIFFERENT THICKNESS OR WHERE THICKNESS VARIES IN JOGGLE AREA, USE GREATEST THICKNESS TO DETERMINE "T".



C

Figure 9. Joggle Dimensions (Sheet 3)

CHART 3

DEPTH OF OFFSET "D"	JOGGLE LENGTH "L"														
	H = 0.50 THRU 1.00			H = 1.01 THRU 1.50				H = 1.51 THRU 2.00				H = 2.01 THRU 2.50			
	"T" IS			"T" IS				"T" IS				"T" IS			
	0.040 THRU 0.078	0.079 THRU 0.094	0.095 THRU 0.125	0.040 THRU 0.062	0.063 THRU 0.102	0.103 THRU 0.156	0.157 THRU 0.188	0.040 THRU 0.062	0.063 THRU 0.125	0.126 THRU 0.188	0.189 THRU 0.250	0.040 THRU 0.078	0.079 THRU 0.124	0.126 THRU 0.188	0.189 THRU 0.250
UP THRU 0.022	0.22	0.23	0.25	0.27	0.27	0.28	0.29	0.30	0.27	0.28	0.29	0.32	0.28	0.28	0.29
0.023 THRU 0.027	0.27	0.27	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.29
0.028 THRU 0.035	0.31	0.31	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.29
0.036 THRU 0.044	0.34	0.34	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.29
0.045 THRU 0.054	0.37	0.38	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.29
0.055 THRU 0.068	0.43	0.41	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.29
0.069 THRU 0.075	0.47	0.43	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.29
0.076 THRU 0.084	0.51	0.46	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.29
0.085 THRU 0.097	0.57	0.51	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.29
0.098 THRU 0.113	0.65	0.57	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.29
0.114 THRU 0.139	0.77	0.67	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.29
0.140 THRU 0.172	0.93	0.80	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.29
0.173 THRU 0.219	1.15	0.87	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.29
0.220 THRU 0.262	1.36	1.14	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.29
0.263 THRU 0.297	1.53	1.27	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.29
0.298 THRU 0.342	1.74	1.45	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.29
0.343 THRU 0.387	1.95	1.62	1.36	2.80	2.36	2.02	1.75	3.78	2.83	2.35	2.03	4.49	3.17	2.84	2.02

CHART 3 (CONT)

DEPTH OF OFFSET "D"	JOGGLE LENGTH "L"											
	H = 2.51 THRU 3.00					H = 3.01 THRU 4.00				H = 4.01 THRU 5.00		
	"T" IS					"T" IS				"T" IS		
	0.050 THRU 0.078	0.079 THRU 0.125	0.126 THRU 0.188	0.189 THRU 0.250	0.251 THRU 0.312	0.050 THRU 0.078	0.079 THRU 0.125	0.126 THRU 0.200	0.201 THRU 0.312	0.062 THRU 0.125	0.126 THRU 0.200	0.201 THRU 0.312
UP THRU 0.022	0.32	0.29	0.28	0.29	0.31	0.32	0.29	0.29	0.29	0.33	0.30	0.27
0.023 THRU 0.027	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17
0.028 THRU 0.035	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17
0.036 THRU 0.044	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17
0.045 THRU 0.054	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17
0.055 THRU 0.058	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17
0.059 THRU 0.075	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17
0.076 THRU 0.084	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17
0.085 THRU 0.097	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17
0.098 THRU 0.113	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17
0.114 THRU 0.139	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17
0.140 THRU 0.172	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17
0.173 THRU 0.219	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17
0.220 THRU 0.262	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17
0.263 THRU 0.297	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17
0.298 THRU 0.342	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17
0.343 THRU 0.387	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17	0.14	0.17

LEGEND

- 1 FOR "R" DIMENSION SEE CHART FOR BRAKE FORMED SHEET.
- 2 TOLERANCE FOR DEPTH OFFSET "D" IN FLAT SHEET IS: $D \pm 0.03$ FOR SHEET THICKNESS OF 0.068 OR LESS.
- 3 $D \pm 0.020$ FOR SHEET THICKNESS OF 0.059 OR GREATER.
- 4 HARDER MATLS REQUIRE ENGINEERING APPROVAL. TOLERANCE FOR DEPTH OF OFFSET "D" IN FLANGED SHEET IS:
 $D = +0.030$ OR -0.010 FOR SHEET THICKNESS OF 0.040 OR LESS AND $D = +0.020$ OR -0.010 FOR SHEET THICKNESS OF 0.040 OR GREATER.
- 5 WHEN IT IS OBVIOUS PART WILL BE PRESS FORMED USE THESE JOGGLE LENGTHS: OTHERWISE DESIGN MUST ALLOW FOR JOGGLE LENGTHS GIVEN UNDER EXTRUDED AND BEND SHEET SECTIONS.

Figure 9. Joggle Dimensions (Sheet 4)

6 SEE FIGURE 1. MINIMUM BEND RADIUS (ALUMINUM).

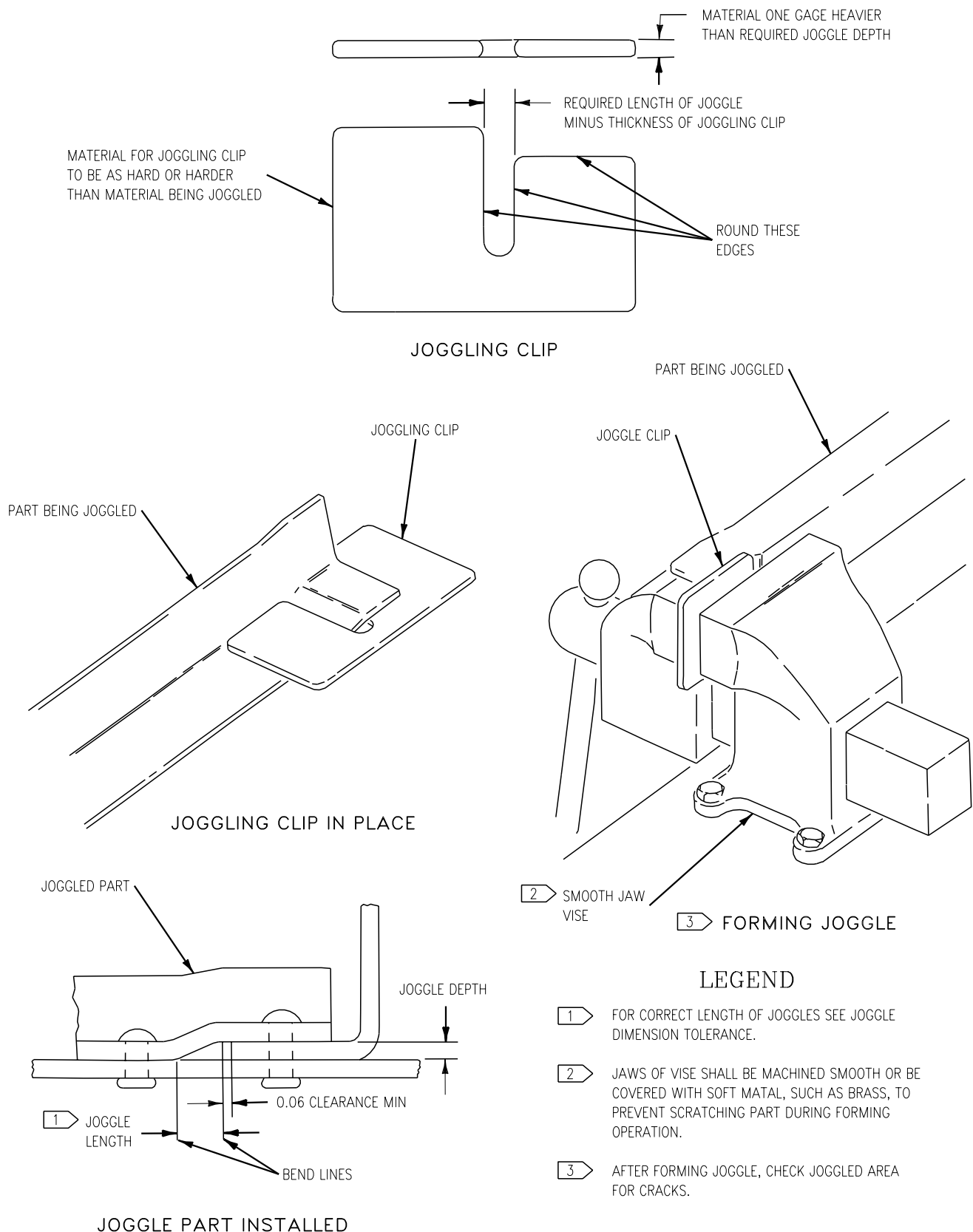
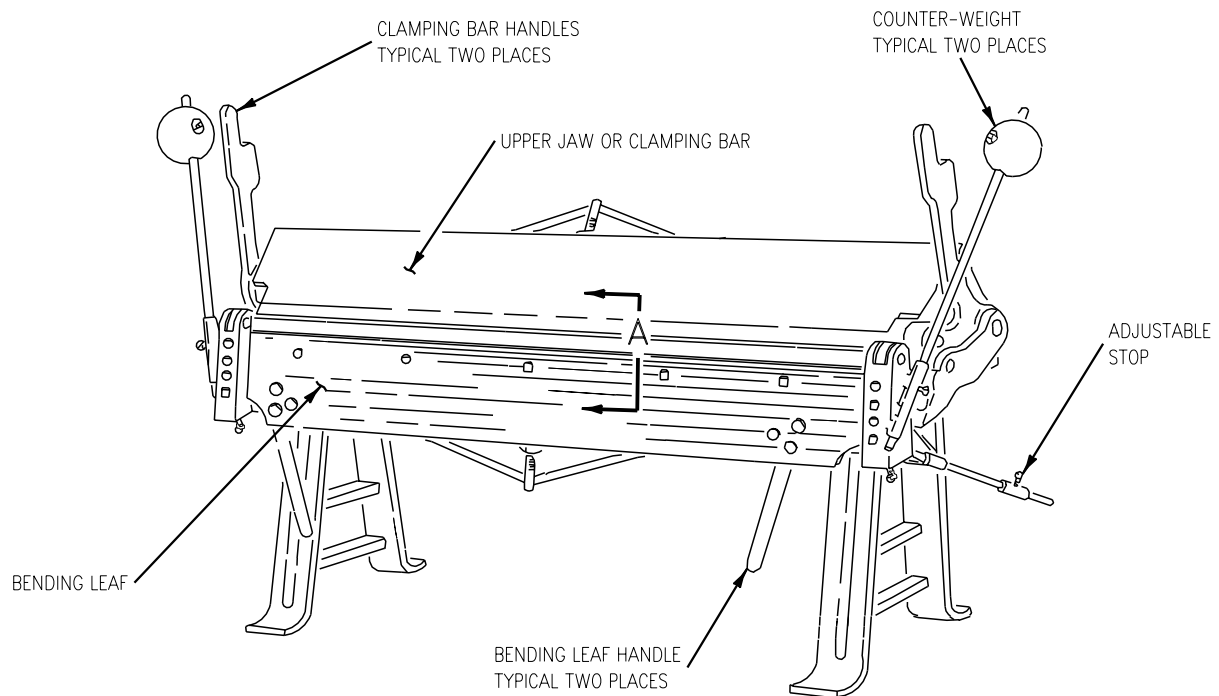
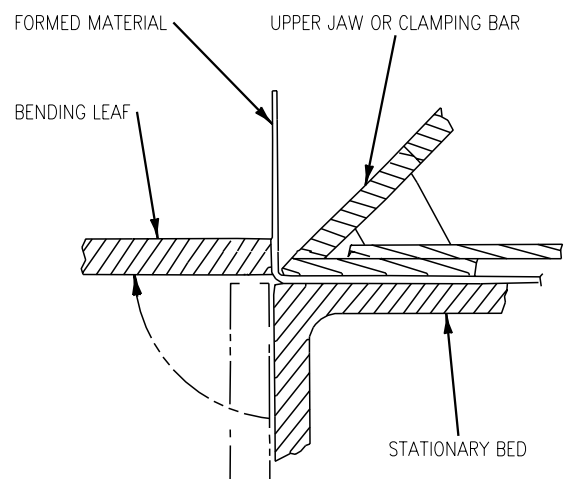
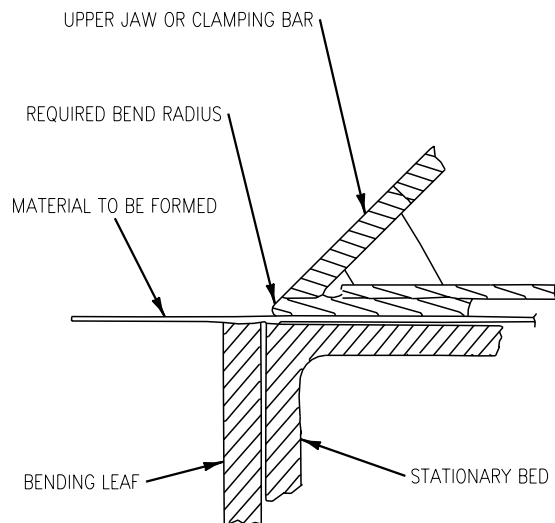


Figure 10. Forming Joggles Using Joggle Clips

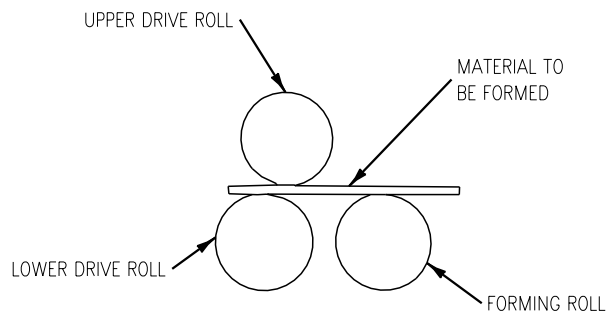
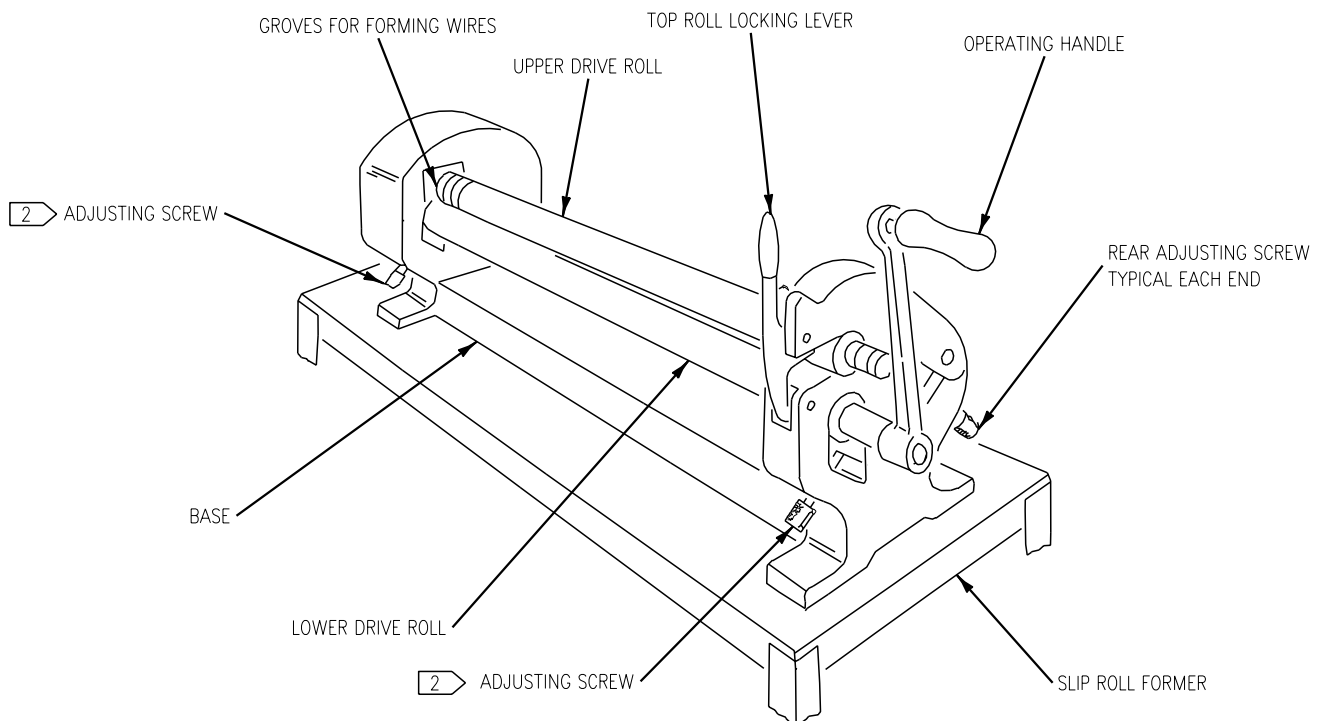


BENDING OPERATION



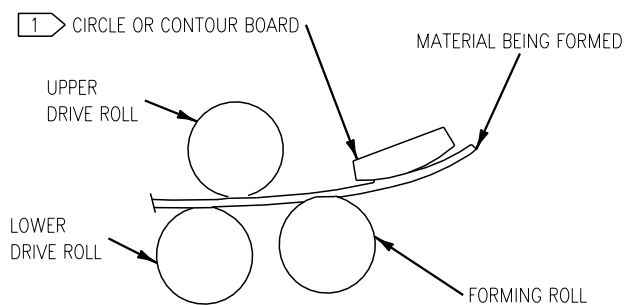
A

Figure 11. Cornice Brake Operation



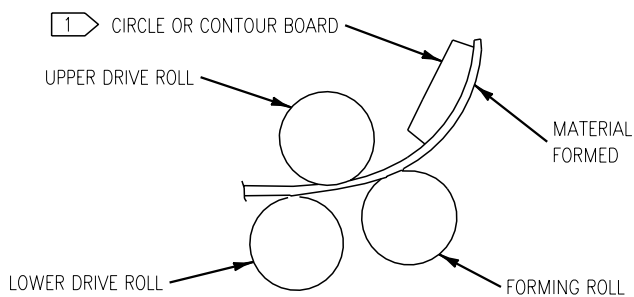
STEP 1.

ADJUST ROLL AND INSERT MATERIAL TO BE FORMED.



STEP 2.

TURN REAR ADJUSTING SCREWS TO RAISE FORMING ROLL AND PASS MATERIAL THROUGH ROLL.



STEP 3.

READJUST FORMING ROLL TO GIVE REQUIRED CURVE AND PASS MATERIAL THROUGH ROLL.

LEGEND

1 CIRCLE OR CONTOUR BOARD SHOULD HAVE A RADIUS EQUAL TO REQUIRED RADIUS OF FORMED PART.

2 TAPERED SHAPES CAN BE FORMED BY TIGHTENING ADJUSTING SCREW ON ONE END OF ROLLS AND LOOSENING SCREW ON OTHER END.

Figure 12. Slip Roll Operation

ORGANIZATIONAL, INTERMEDIATE, AND DEPOT MAINTENANCE

STRUCTURE REPAIR

SHOP PRACTICES

WORKING TITANIUM ALLOY

Reference Material

Nondestructive Inspection.....	A1-F18AC-SRM-300
Penetrant Method.....	WP004 00
Nondestructive Inspection Methods.....	NAVAIR 01-1A-16
Structure Repair, General Information.....	A1-F18AC-SRM-200
Forming Sheet Metal.....	WP004 01
Fasteners.....	WP004 06
Aircraft Corrosion Control.....	A1-F18AC-SRM-500
Cleaning.....	WP006 00

Alphabetical Index

Subject	Page No.
Introduction.....	1
Cutting and Grinding.....	2
Drilling and Reaming.....	3
Free-Hand Drilling.....	4
Forming Titanium.....	7

Record of Applicable Technical Directives

None

1. INTRODUCTION.

2. Titanium alloy is relatively lightweight, corrosion resistant, structural metal. Because of its physical properties, special techniques are required in working and forming of titanium.

Support Equipment Required

NOTE

Alternate item type designation or part numbers are listed in parentheses.

Part Number or Type Designation	Nomenclature
NAS 907 Types D, E, or J	Cobalt High Speed Steel Drills, M-33,M-42,#40, and 1/8

**Support Equipment Required
(Continued)****NOTE**

Alternate item type designation or part numbers are listed in parentheses.

Part Number or Type Designation	Nomenclature
GGG-R-180D (—)	Carbide Reamer (8 % Cobalt)
GGG-C-163D (—)	Carbide Countersinks (8 % Cobalt)
H-B-178/1 — — — — —	Wire and Platter Brush Counterbore Stepdrill drill Stop Vixen Block Drill Motor
COMMERCIAL	'C'-Clamp

Materials Required**NOTE**

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
No. 4367	Turco
No. 4316	Turco
O-N-350	Nitric Acid, Technical
O-H-795	Hydrofluoric Acid
O-F-371	Sodium Bicarbonate
PURPLE K-50LB O-D-1407	Dry Chemical, Fire Extinguishing Powder, Sodium Bicarbonate, Dry
MIL-C-47220	Dielectric Coolant Fluid
D 1153	Methyl Isobutyl Ketone
MIL-STD-1202	Face Shield
ZZ-G-381, TYPE 1, STYLE 1	Chemical Gloves, Rubber Gloves
ZZ-A-605	Acid Resistant Apron
ANSI B74.2-74, TYPE C60J5V	Grinding Wheel, Silicon Carbide
ANSI B74.2-74, TYPE C60N5V	Grinding Wheel, Silicon Carbide
500NF	Bio-Cool
MMS611	Lubricant

Materials Required (Continued)**NOTE**

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
IMMUNOL #1809 COMMERCIAL	Lubricant Synthetic Nonwoven Wipers
ISOPAR M —	Coolant, With 1 Per cent Butyl Cellosolve Cetyl Alcohol, Stick Form
AA1048TY1CL1 GRIT809X11	Aluminum Oxide Abra- sive Cloth
A-A-1047 GRIT 80 9X11 or Finer	Abrasive Paper, Silicone Carbide, Waterproof

3. CUTTING AND GRINDING. Cutting titanium is intermediate maintenance and grinding titanium is organizational maintenance.

a. Conventional saw equipment can be used in cutting titanium if care is used in applying pressure. Fairly heavy pressure is required because there is tendency for metal surface to work harden if blade is allowed to ride across metal. During sawing operation, metal may have tendency to tear and clog saw blade.

b. Shears used for cutting steel may also be used to cut titanium if shears are kept sharp and in good adjustment.

c. Grinding removes metal slowly and poor surface finish with heavy burring results.

d. Titanium is subject to cracking if rough areas are present. All cut and trimmed edges shall be filed free of burrs, grooves, scratches, and sharp corners before forming or assembly is started.

WARNING

Fire hazard exists when grinding titanium. Titanium dust can be easily ignited when dry. Below precautionary measures shall be taken.

e. Precautionary measures:

(1) Enough dielectric coolant fluid shall be used to rapidly quench sparks during grinding operations.

(2) Keep external surfaces of machines clear of titanium dust.

(3) Titanium dust shall not be allowed to accumulate in work area.

(4) Open flame or spark producing tasks shall not be done in area containing titanium dust or chips.

(5) Sodium bicarbonate dry chemical shall be readily available in grinding area for extinguishing titanium fires.

NOTE

Use flood of dielectric coolant fluid when machine grinding.

f. Titanium shall be ground only with machines equipped with controllable speed and coolant flow regulator. Use silicone carbide wheels to grind titanium. Wheels shall be kept sharp by redressing to prevent load up and discoloration, smearing, or glazing of metal surface.

NOTE

Peripheral speed, S.F.M., may be determined using following formula: (.26)

$$X \text{ grinding wheel diameter} \times \text{tool rpm} = \text{S.F.M.}$$

(1) Surface grinding shall be done with "J" grade wheel at 2500 S.F.M. with minimum work speed of 40 feet per minute.

(2) Rough grinding shall remove maximum of 0.001 inch per pass.

(3) Finish grinding shall consist of three passes removing 0.0005 inch per pass plus minimum of two passes removing 0.00025 inch per pass.

(4) Edge grinding shall be done with "N" grade wheel at 3,000 S.F.M. with minimum work speed of 40 feet per minute.

NOTE

Discoloration will not occur if step f. is followed.

g. Grinding discoloration:

(1) Yellow - normal when grinding titanium and is acceptable.

WARNING

Methyl isobutyl ketone is flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

(2) Blue or purple - overheat condition. If blue or purple discoloration can not be removed with methyl isobutyl ketone, part shall be replaced.

h. Example of typical grinding wheel number; C60J5V.

(1) Number - A or C.

A - Aluminum oxide.

C - Silicon carbide.

(2) Grain Size - 60.

(3) Hardness - J or N, J is maximum.

(4) Structure - 5.

(5) Type of bond - V.

4. DRILLING AND REAMING. Drilling and reaming is intermediate maintenance. Standard M-33/M-42 cobalt high speed drills; NAS907, Types D, E, or J, will do satisfactorily in drilling titanium if drills are sharp, enough force is applied, and slow speed motor is used.

a. Dull drill, or if drill is allowed to ride in partly drilled hole, will cause overheat condition and make further drilling extremely difficult.

b. If overheat condition occurs, indicated by blue discoloration, and discoloration cannot be removed with methyl isobutyl ketone, part shall be replaced.

NOTE

It is recommended, when available, cobalt drills, reamers, and cutting tools be used.

c. Use cobalt or 8 percent cobalt drills, reamers, or countersinks when working titanium. See figure 1 for drill shapes and speeds to be used for drilling titanium.

d. Drills and reamers shall be rotating when withdrawn from hole to prevent scoring sides of hole.

e. Reamers shall be used at one half drill speed.

5. **FREE-HAND DRILLING.** Free-hand drilling is intermediate maintenance.

a. Apply enough force to keep drill cutting continuously.

b. Excessive force may bow or bend drill causing elongated holes and tool breakage. Lack of force will dull drill quickly.

c. Use shortest drill with shortest flutes possible.

d. Undersize pilot holes; #40 or 0.125 inch dia. may be used to reduce force required for feeding.

e. When reaming, countersinking, and counterboring, force required to maintain constant feed rate normally will be less than required for drilling.

f. When drill or reamer exits on back side of structure being drilled, slowly rotate drill motor clockwise while pulling tool back through hole. Do not stop or reverse rotation when removing tool from hole.

6. Requirements.

a. Drill motors shall not be triggered and air hoses shall not be 'C'-Clamped to reduce drilling

speeds below maximum allowed. Always use drill motors with rated speeds below specified maximum limits.

b. Temperatures at periphery of hole(s) during drilling shall be kept to minimum so not to cause;

(1) Discoloration of bare metal.

(2) Discoloration of painted surfaces.

(3) Excessive coolant vaporization.

c. To get best possible hole tolerance, hole finish, and to prevent tool breakage, always support thin gage material on exit side of hole, if possible.

d. Drilling and reaming holes through combination of dissimilar alloys, use feed and speed requirements of harder material. Drilling or reaming direction shall be from side of harder material.

e. Frequent drill and reamer withdrawal and use of lubricants may be required when working from side of softer material.

f. When using step drills, first step must drill completely through material before final step of drill begins cutting.

g. Tool marks at 45 degree angle or less, with axis of hole are not acceptable.

h. Paper and synthetic nonwoven wipers shall not be used for final cleaning of painted, bare, or exterior surfaces of aircraft.

i. When drilling into parts near electrical wires or equipment, fluid lines, control cables, or inner structure, drill stops shall be used. Drill stop should be adjusted to limit drill point to 1/16-inch penetration beyond sheet or part. Use of drill with 135 degree angle drill point may be used to minimize penetration. See figure 1.

7. Hole Quality.

a. Visual Inspection:

(1) Discoloration of bare/painted surfaces around periphery of hole(s) is indication of over heating, submit request for engineering disposition.

(2) Burrs around holes shall be removed.

(3) Hole finish should be RHR 125 or better.

(4) Holes or countersinks shall meet following;

(5) No tool marks or scratches allowed 45 degrees or less with hole axis.

(6) Make sure tool marks or scratches do not cause surface finish of hole(s) or countersink(s) to exceed specified limits.

NOTE

Surfaces with tool marks or scratches may be reworked to pass visual and dimensional inspection.

(7) Tool marks shall not exceed 0.001 inch.

b. Dimensional Inspection:

(1) Make sure hole location and edge distance are correct.

(2) All holes shall be drilled normal to surface, as required.

(3) All holes shall be drilled within minimum or maximum specifications.

(4) All countersinks shall have correct diameter, included angles, alignment, or intersection radii; allowing correct seating of fastener head within flushness and gap ranges specified in specific procedure work package.

c. Inspection Frequencies:

(1) Inspect all hole(s) when cold worked, during interference fastener removal/installation, or when specifications require 100 percent inspection.

(2) When hole(s) require tolerance of 0.003 inch or less, inspect 100 percent..

(3) If hole pattern is four or less holes inspect 100 percent.

(4) If hole pattern is 4 to 30 holes, inspect 3 randomly selected holes in pattern.

(5) If hole pattern is over 30 holes inspect 10 percent of holes randomly selected.

(6) If any hole is rejected, inspect all remaining holes in pattern.

(7) Holes having total diametrical tolerance greater than 0.003 inch, inspection to reasonably make sure visual and dimensional acceptance criteria specified are being met and maintained.

d. Hole shall be normal to surface upon which fastener head will seat.

e. For head gap, tilt, and other specific criteria see (A1-F18AC SRM-200, WP004 06) or specific procedure work package.

f. Cylindrical holes and countersinks shall not be out of round or tapered to extent high and low limits of hole tolerance is exceeded.

g. Concentricity of hole, countersink, and radius shall meet specifications of fastener(s) to be installed.

h. Hole finish shall meet requirements of specific procedure work package.

i. Before deburring, burrs and material surrounding holes shall be inspected for discoloration caused by excess temperature due to excess speed/dull drill. If discoloration can not be removed with solvent, holes shall be rejected and submitted for engineering disposition.

j. Primed and painted surfaces surrounding holes shall be examined for discoloration due to excessive temperatures. if discoloration can not be removed with solvent, holes shall be rejected and submitted for engineering disposition.

8. Hole Cutting Tools.

a. Titanium alloys shall be drilled using 8 percent cobalt H.S.S. or carbide tools.

b. Cutting tools that are bent, damaged, dull, or incorrectly sharpened shall not be used.

c. Tools having smeared metal bonded or welded to margins shall not be used for making finish holes.

d. Countersink, counterbore, spotface, and reamer pilot diameters shall be 0.001 to 0.004 inch smaller than diameter of hole to prevent tool chatter marks and out of tolerance conditions.

e. Deburring tools, Vixen Blocks, refer to paragraph 12, must meet following requirements;

- (1) Attach screws must be recessed.
- (2) Edge distance must be adequate to prevent contact with skin surface.
- (3) Teeth must not be allowed to be clogged.
- (4) Drilling speeds shall not exceed table 1 requirements.

(5) Drill motors having wobbly chucks, loose and worn bearings, or worn gears causing vibration/uneven feed rates shall not be used.

(6) All drill motors shall be marked with maximum speed rate.

Table 1. Maximum Speeds for Free-hand Assembly Drilling

Material to be Drilled	NAS 907	Maximum							
		#40	1/8	3/16	1/4	5/16	3/8	7/16	1/2
Titanium Alloys	Type D and E	1000	1000	500	500	300	250	200	150
NOTE: 1. Free-hand assembly drilling/reaming of holes larger than 1/4-inch in titanium is not recommended without drilling aids.									

9. Lubricants.

a. Approved lubricant shall be used, as required, see table 2.

Table 2. Lubrication Chart for Titanium Alloys

Lubrication Type	Application Method
Dry	None
ISOPAR M	Mist
MMS611	Mist or Flood
IMMUNOL	Mist or Flood
BIO-COOL	Mist or Flood
CETYL ALCOHOL	Stick

b. Mix ratios are, water/lubricant, as below;

- Bio-cool and 500NF 20 to 1.
- MMS611 and Immunol #1809 30 to 1.

c. Mixing lubricants or use of deteriorated or contaminated lubricants is prohibited.

d. Spray mist applied Isopar M, containing 1 percent Butyl Cellosolve, may be used for all assembly drilling of bare and primed parts and assemblies, assemblies having faying surface sealed areas, and assemblies which cannot be separated for cleaning. When Isopar M is correctly spray mist

applied, cleaning of parts and assemblies is not required by other applicable cleaning requirements for sealing, bonding, or painting.

e. Cetyl alcohol, in stick form, applied to tool before use, may be used as lubricant in areas where other lubricants are not practical. Disassembly and cleaning of parts is not required after use of cetyl alcohol if applied per this step.

f. When water based coolants, applied either by flood or mist are used for assembly drilling, assemblies shall be disassembled and solvent cleaned per (A1-F18AC-SRM-500, WP006 00) to remove all traces of lubricant.

g. Bonded structures and assemblies that can not be separated for cleaning, water based coolants can be used only by dipping cutting tool into coolant and allowing excess coolant to drip off before use.

10. Tool Feed and Speed.

a. Drill shall not be allowed to dwell on material without cutting. Force shall be applied to drill immediately on contact with material being drilled.

b. Drill speeds in relation to hole size and material, shall be per table 1.

c. Speed for reaming, countersinking, and counterboring shall be 1/3 to 1/2 of maximum drilling speeds specified in table 1 for drilling.

11. Hole Alignment, Gaps, and Preload. All parts shall be securely fastened together before drilling/reaming through more than one thickness. There are no exceptions allowed on joints that can not be disassembled for cleaning and deburring.

12. Deburring.

a. Holes shall be free of dirt or contaminants that may be imbedded into surface during deburring (A1-F18AC-SRM-500, WP006 00), Solvent Cleaning.

b. Use only clean abrasive cloths or abrasive papers.

c. Use 80 grit or finer abrasive cloth/paper for normal deburring. Vixen blocks used for deburring must meet the following;

(1) Attach screws must be subsurface.

(2) Edge radii must be enough to not allow contact with skin surface.

(3) Cutting teeth must be ground off leaving 0.005 inch flats.

(4) Teeth must not be clogged by foreign material.

d. Fastener holes may be deburred with H.S.S. or carbide rotary deburring tools; however, speeds shall not exceed 250 S.F.M.

e. Deburr hole(s) using Vixen Block as follows;

(1) Use light pressure with limited stroke. Excess pressure will cause tool to dig or grab, possibly cause burr to jam in tool and scratch periphery of hole. Stroke should be lower than required to cover area to be deburred.

(2) Use forward direction only. Do not use forward/aft, scrubbing, procedure. Forward and aft procedure may trap chips and become cutting agent.

(3) Clean chips from tool after each stroke. Cleaning prevents trapping chips in tool and causing scratches/gouges in material.

(4) Do not use defective tool. Defective tools pick up chips and cause scratching.

13. FORMING TITANIUM. Moderate forming with no stress relief is intermediate maintenance all other forming and heating processing is depot maintenance. Forming of titanium falls into three classes:

a. Moderate cold forming with no stress relief.

b. Severe cold forming stress relief.

c. Elevated temperature forming, built-in stress relief.

14. Cold Forming. Parts with bends less than 15°, roll formed, or bend parts with radii greater than 15 times thickness of metal, and parts lined up with less than one percent permanent set do not require stress relieving or annealing.

15. Hot Processing. If titanium is formed more severely than indicated in paragraph titled Cold Forming, one or more of following heat processes must be used:

a. Forming; initial or final, in heated tools such as creep form blocks, or from preheated sheet.

b. Bulk stress relieving in furnace after forming.

c. Annealing after partial forming operation to remove effects of work hardening and simplify finish forming. All of these operations, by relieving internal strains, counteract tendency to crack or to creep back toward original shape of sheet. For all three operations part must be cleaned and covered with protective coating to prevent oxidation when parts are heated. When all operations are completed, parts are pickle cleaned. Requirements for furnaces are the same for all three operations.

16. Elevated Temperature Forming. Forming titanium at elevated temperatures is advantageous because it is possible to produce smaller bend radii, less springback and increased elongation. Following steps cover requirements and procedures for forming titanium and titanium alloy material at elevated temperatures:

a. Form blocks and dies. To get desired shape, dies and form blocks may be used (WP004 01) , except only steel or ferrous metals will be used. Blocks, dies, and bend radius bars used in bending

titanium shall not be allowed to become coated or covered with any form of iron oxide in form of rust, or heavy scale. Light, tightly adhering film, or discoloration on ferrous material shall not be considered as harmful.

b. Stress relieving and annealing. Parts must be stress relieved if either cold forming is more severe than allowed in paragraph titled Cold Forming, or hot forming temperatures that fall above those

specified in tables 3 and 4. Stress relieving shall be done within 24 hours after final forming operation and before part is installed on aircraft. Annealing is used on parts which are formed to several different steps. This annealing process restores metal to its softest and most workable condition allowing forming operation to continue without damage to material. Stress relieving is used on finished formed parts to remove any internal stresses in metal caused by forming operation.

Table 3. Stress Relief

Material Specification	Material	Temperature Degrees F.	Time At Temperature	Cooling Rate
AMS-4917	Ti-13V-11Cr-3Al	See Table 2 for Annealing		
AMS-4926	Ti-5Al-2.5Sn	1100 \pm 25	1/2 to 2 hours	Air cool to room temperature.
MIL-T-9046, Type I, Composition B Annealed	Unalloyed Titanium	975 \pm 25	1/2 to 1 hour	Air cool to room temperature.
MIL-T-9046, Type II, Composition A Annealed	Ti-5Al-2.5Sn	1100 \pm 25	1/2 to 2 hours	Air cool to room temperature.
MIL-T-9046, Type III, Composition A Annealed	Ti-8Mn	900 to 1100	1/2 to 2 hours	Air cool to room temperature.
MIL-T-9046, Type III, Composition C Annealed	Ti-6Al-4V	1150 \pm 25	1/2 to 2 hours	Air cool to room temperature.
MIL-T-9046, Type II, Composition F Single Anneal	Ti-8Al-1Mo-1V	1100 \pm 25	1 to 2 hours	Air cool to room temperature.
MIL-T-9046, Type II, Composition F Duplex Anneal	Ti-8Al-1Mo-1V	See table 2 for Annealing		
MIL-T-9046, Type I, Composition A	Unalloyed Titanium	975 \pm 25	1/2 to 1 hour	Air cool to room temperature.
MIL-T-9047, Type III, Composition C Annealed	Ti-6Al-6V-2Sn	1100 \pm 25	1/2 to 2 hours	Air cool to room temperature.

Table 4. Annealing

Material Specification	Temperature Material	Temperature Degrees F.	Time At Temperature	Cooling Rate
AMS-4917	Ti-13V-11Cr-3Al	1450 \pm 25	1/4 to 1 hour	Air cool to room temperature.
AMS-4926	Ti-5Al-2.5Sn	1325 to 1550	1/4 to 4 hours	Air cool to room temperature.
MIL-T-9046, Type I, Composition B Annealed	Unalloyed Titanium	1000 to 1300	1/2 to 2 hours	Air cool to room temperature.
MIL-T-9046, Type II, Composition A Annealed	Ti-5Al-2.5Sn	1325 to 1550	1/4 to 4 hours	Air cool to room temperature.
MIL-T-9046, Type III, Composition A	Ti-8Mn	1275 \pm 25	1 hour	Furnace cool to 900°F max rate of 50°F per hour. Air cool to room temperature.
MIL-T-9046, Type III, Composition C Annealed	Ti-6Al-4V (Sheet, Plate up to 5/8 inch thick)	1325 to 1450	1 hour	Air cool to room temperature.
MIL-T-9046, Type II, Composition F Single Anneal	Ti-8Al-1Mo-1V	1450 \pm 25	1 to 2 hours	Furnace cool to 900°F at max rate 50°F per hour. Air cool to room temperature.
MIL-T-9046, Type II, Composition F Duplex Anneal	Ti-8Al-1Mo-1V	1450 \pm 25	1/4 to 1 hour	Air cool to room temperature.
MIL-T-9047, Type I, Composition A	Unalloyed Titanium	1000 to 1300	1/2 to 2 hours	Air cool to room temperature.
MIL-T-9047, Type III, Composition C Annealed	Ti-6Al-6V-2Sn	1300 to 1500	2 to 3 hours	Furnace cool to 1000°F max at a rate not greater than 300°F per hour. Air cool to room temperature.

c. Cleaning and oxidation protection. Before parts are placed in hot dies or furnace, they must be protected by anti-oxident coating. This protective coating allows final cleaning and reduces metal loss due to surface scaling.

WARNING

Methyl isobutyl ketone is flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

(1) Clean surface with solvent or vapor degrease to remove all oil, grease, identification marking, oxides, fingerprints, and other surface contamination.

WARNING

Hydrofluoric and nitric acids will cause serious injury if not handled correctly. Wear acid resistant gloves, protective face shield, and approved protective clothing. If acid contacts skin or eyes, flush affected area immediately with water. Report to medical facility if eyes are affected or skin is burned.

Never add water to concentrated acid. Adding water to concentrated acid will cause an explosion due to rapid expansion of acid.

(2) Mix nitric-hydrofluoric acid pickle solution as follows;

(a) Fill tank to 50 percent of operating level with water.

(b) Add nitric acid slowly to 82 percent of operating level while carefully stirring.

(c) Add hydrofluoric acid slowly while stirring to 84.5 percent of operating level.

(d) Add water to operating level and stir to mix.

(3) Immerse part(s) in acid solution for 10 to 30 seconds.

(4) Thoroughly rinse parts by immersion in cold running water.

(5) Stains caused by pickling may be removed by immersion for 30 seconds in nitric acid solution at temperature of 70° to 90° F. Solution consist of:

Nitric Acid (40 Be)	45 - 55 % by volume
------------------------	------------------------

Tap water	remainder by volume
-----------	------------------------

(6) Thoroughly rinse parts by immersion in cold running water.

NOTE

If forced drying is used, dryer must be electrically heated or, if heated by gas or other fuel, it must be designed with provisions to prevent direct contact of part(s) with flame, partly or completely combustible fuels, or fuel gases.

(7) Dry part(s) soon as possible after rinsing to prevent water stains.

(8) Spray surface with one coat Turco No. 4367 and allow to dry for 10 minutes before handling. Coating shall be smooth continuous film and reasonably free of surface irregularities.

WARNING

Forced or compressed air shall not be blown in direct stream on titanium because of possibility of sparking. This sparking is caused by minute particles of dirt striking surface at high velocity.

d. Heating.

(1) Furnaces are electrically heated or muffle type if fuel fired, to prevent direct contact between titanium and any products of combustion.

(2) Use of any controlled atmosphere containing carbon or hydrogen, or any compound thereof is prohibited.







(3) Any furnace used shall be capable of maintaining uniform temperature within plus or minus 25° F of required temperature.

(4) When parts are heated they shall be supported in furnace by clean, dry fire brick, or other ceramic material, or by some ferrous material, provided such supports are free from iron oxide in form of rust or heavy scale.

(5) Light, tightly adhering film or discoloration of ferrous materials shall not be considered harmful.

(6) Forming temperature range for furnace heating and maximum time at that temperature is shown in table 5.

Table 5. Forming Temperature And Time Limits

Material	Condition	Forming Temperature	Total Accumulated Time At Temperature
Unalloyed Ti	Annealed	950-1200° F	4 Hours
Ti-8Mn	Annealed	950-1200° F	4 Hours
Ti-6Al-4V	Annealed	1200-1425° F	4 Hours
Ti-6Al-6V-2Sn	Annealed	 1200-1350° F	4 Hours
Ti-5Al-2.5Sn	Annealed	1200-1450° F	4 Hours
Ti-8Al-1Mo-1V	Single Annealed	 1100-1450° F	1 Hour
	Duplex Annealed	 1450° F	1 Hour
<p>NOTES</p> <p> 1 Beta stabilization heat treatment shall be done on all parts air cooled from forming temperature. Beta stabilization is a done after forming and shall consist of heating to 1050-1150° F, holding at temperature for 1-2 hours then; air cool to room temperature. Beta stabilization treatment is not required when parts are furnace cooled to below 900° F from forming temperature.</p> <p> 2 If formed above 1150° F, this material must be reprocessed to maintain single annealed condition. Reprocessing shall consist of heating to 1450° ±15° F for 30-60 minutes, furnace cooling to 900° F at maximum rate of 50° F per hour, then air cool.</p> <p> 3 This material must be air cooled from 1450° F to maintain duplex annealed condition.</p>			

(7) Heating temperature shall be kept as low as possible, depending upon amount of forming required since excessively high temperature will cause surface scaling and contamination.

(8) Time limits for various temperature shown in table may be cumulatively proportioned. For example: part made of AMS 4901 material has been heated to 900° F for four hours and then it is desired to heat it to higher temperature for final forming. Since only 1 hour 20 minutes of permitted time at 800° to 1150° range was used, 7 hours and 40 minutes of exposure time remains. For that reason, it would be allowed to heat to temperature

from 800° to 1150° F for 7 hours and 40 minutes. Time at temperature shall be total time part is in furnace.

(9) After forming, allow part to air cool before performing final stress relieving.

17. Cleaning of Completed Parts. During annealing and stress relieving operation, certain amount of scale and contamination will form on surface of titanium part. Scale and contamination can be removed after part has been cleaned with alkaline cleaner by one of two steps depending upon temperature at which surface scale was formed.

WARNING

Hydrofluoric and nitric acids will cause serious injury if not handled correctly. Wear acid resistant gloves, protective face shield, and approved protective clothing. If acid contacts skin or eyes, flush affected area immediately with water. Report to medical facility if eyes are affected or skin is burned.

Never add water to concentrated acid. Adding water to concentrated acid will cause an explosion due to rapid expansion of acid.

a. If scale was formed at temperature below 1000°F, it can be removed by soaking part up to 10 minutes in nitric-hydrofluoric pickle solution at temperature of 130° to 140°F. Nitric-hydrofluoric pickle solution consist of:

Nitric Acid (40 Be)	27 - 32 % by volume
Hydrofluoric acid (70 %)	1.6 - 2.5 % by volume
Tap water	remainder by volume

b. Mix acid solution as follows:

(1) Fill tank to 50 percent of operating level with water.

(2) Add nitric acid slowly to 82 percent of operating level while carefully stirring.

(3) Add hydrofluoric acid slowly while stirring to 84.5 percent of operating level.

(4) Add water to operating level and stir to mix.

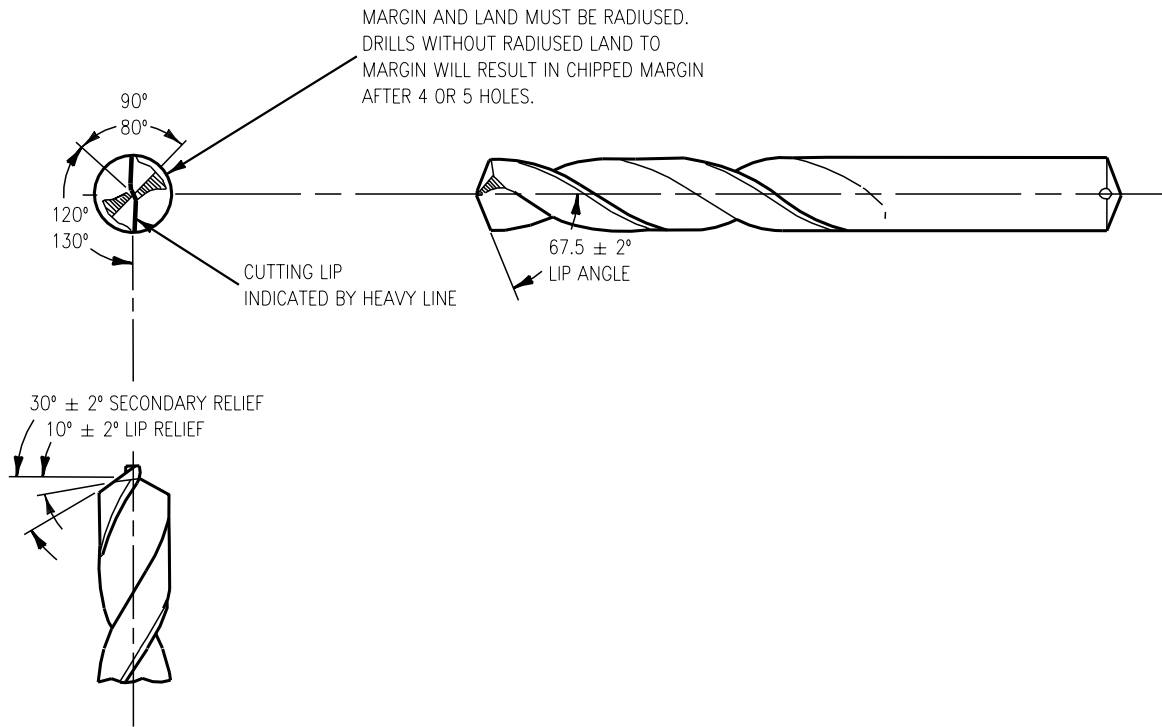
c. If scale was formed at temperature above 1000°F, it can be removed by soaking part for half hour in Turco 4316 solution and then 2 to 5 minute immersion in nitric-hydrofluoric pickle solution at temperature of 130° to 140°F. Turco 4316 solution consist of:

Turco 4316	8.3 pounds
Tap Water	1 gallon

d. Removal of surface scale and contamination may be aided by scrubbing surface with wire brush and reimmersion.

e. After parts have been cleaned by using one of above solutions, give parts final rinse in cold running water and dry.

18. **Inspection.** When any limits of cold forming, stress relieving, or heating have been exceeded, part shall be fluorescent penetrant inspected for cracks (A1-F18AC-SRM-300, WP004 00) and (NAVAIR 01-1A-16).



DRILL SPEEDS		
DRILL SIZE	HAND DRILL RPM 1	MACHINE DRILL RPM
NO. 60 TO NO. 40	2000	750
NO. 39 TO NO. 30	1000	600
NO. 29 TO NO. 21	1000	500
NO. 20 TO NO. 10	750	300
NO. 9 TO E	500	300
F TO 5/16	250	200
0 TO 3/8	250	150
V TO 1/2		

LEGEND

- 1 AUTOMATIC FEED/SPEED POWER ASSISTED DEPOT TOOLS.
- 2 HAND DRILLING OF HOLES LARGER THAN 0.250 INCH DIAMETER WITHOUT DRILLING AIDS IS NOT RECOMMENDED.

Figure 1. Drills for Titanium

ORGANIZATIONAL MAINTENANCE

STRUCTURE REPAIR

SHOP PRACTICES

LOCATING BLIND HOLES AND TRIM LINES

Reference Material

Structure Repair, General Information	A1-F18AC-SRM-200
In-service Tolerances	WP008 00

Alphabetical Index

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Record of Applicable Technical Directives

None

1. BACKGROUND.

2. General requirements to do any repair or replacement of structure are to pick up existing hole patterns and establish trim lines. This work package outlines procedures to follow when doing these operations.

3. **LOCATING BLIND HOLES.** Three methods of locating blind holes are shown in figure 1. Each method, the hole finder, blind hole transfer punches, or measuring and scaling, can be used to locate blind holes. As a general guide, parts relatively flat, such as replacement skins and one piece doors, can most accurately have holes located using blind hole transfer punches or a hole finder. Parts that are more rigid such as extruded shapes, parts with compound curved surfaces, and built-up assemblies can have holes most accurately located by using measuring and scaling method. A more detailed explanation of each method is outlined below:

a. Hole Finder Method. The hole finder may be made of various materials and of special shapes and sizes to fit a specific job. A temporary or one-time-use tool may be fabricated in a few minutes from any scrap of hardened aluminum alloy and a rivet of desired size. It is recommended that when a large number of holes are to be drilled, prefabricated tool or one made of steel with steel drill bushing be used. Locate blind holes in part using hole finder method as shown in figure 1, and substeps below:

(1) Put new part in position.

(2) Install fasteners in all existing full size holes. If part has no holes or has only pilot holes or undersize holes, tape part in place.

(3) Using hole finder, inspect location of all existing pilot holes in relation to existing holes in structure before bringing them to final size.

(4) Remove part from structure and drill several holes to final size.

(5) Reinstall part with temporary fasteners. Locate and pilot drill remaining holes.



Be careful when bringing holes to final size. Holes must not be drilled off center. Several intermediate size twist drills should be used before holes are brought to final size. Visual inspection of hole alignment should be made as drilling progresses.

(6) Remove part from structure and drill holes to final size.

(7) Deburr holes.

b. Blind Hole Transfer Punches. Blind hole transfer punches provide an accurate method of locating blind holes in a part. Locating blind holes in a part using blind hole transfer punch method may be done as shown in figure 1 and substeps below:

(1) Determine hole sizes in part.

(2) Select correct size blind hole transfer punch from table on figure.

(3) Insert transfer punches into selected holes.

(4) Place new part in position and lightly tap part over each transfer punch.



Be careful when bringing holes to final size. Holes must not be drilled off center. Several intermediate size twist drills should be used before holes are brought to final size. Visual inspection of hole alignment should be made as drilling progresses.

(5) Remove part from structure and drill holes to final size.

(6) Deburr holes.

c. Measuring and Scaling Method. With measuring and scaling method, blind holes are

located by either measuring predetermined amount along line passing through center of existing hole or by locating intersecting point of two lines passing through center of hole. Locating blind holes in a part using measuring and scaling method may be done as shown in figure 1 and substeps below:

(1) Draw line through center of existing hole in structure and mark off measured distance on line from centerline of hole or draw two lines intersecting at center of hole.

(2) Put new part in position.

(3) Install fasteners in all existing full size holes. If part has no holes or has only pilot holes or undersize holes, tape part in position.

(4) Inspect location of all existing pilot holes in relation to existing holes in structure by placing scale or straight edge along uncovered part of line and project lines on new part. Mark measured distance along projected line or extend two lines until lines intersect. If there are no full size holes in part, adjust new part so as many of the pilot holes as possible are located in center of existing holes in structure.

(5) On parts that have no holes, place scale or straight edge along uncovered part of lines of several holes and project lines on new part. Mark measured distance along projected line or extend two lines until lines intersect.

(6) Center punch intersection mark and drill pilot hole.



Be careful when bringing holes to final size. Holes must not be drilled off center. Several intermediate size twist drills should be used before holes are brought to final size. Visual inspection of hole alignment should be made as drilling progresses.

(7) Remove part from structure and drill holes to final size.

(8) Reinstall part with temporary fasteners. Locate and pilot drill remaining holes.



Be careful when bringing holes to final size. Holes must not be drilled off center. Several intermediate size twist drills should be used before holes are brought to final size. Visual inspection of hole alignment should be made as drilling progresses.

(9) Remove part from structure and drill remaining holes to final size.

(10) Deburr holes.

4. LOCATING TRIM LINES. Two methods of locating trim lines are shown in figure 2. Either skin scribe or tape method may be used to accurately locate trim lines for oversize cover plates, skin panels, and doors. Skin scribe method is equally useful for making trim lines of irregular as well as straight lined flush patches, cover plates, skin panels, and doors. Tape method is best used on rectangular or straight edge openings. With either method used in trimming parts, consideration must always be given to mismatch and gap between parts for contour smoothness requirements (WP008 00). More detailed explanation of each method is outlined in steps below:

a. **Skin Scribe Method.** The skin scribe may be made of any available steel that will take and hold a good scribing edge. The turned down tip on lower strap is bent as sharply as possible and rounded to about 1/4-inch radius. It should be polished so it will slide smoothly along inside edge of cutout being matched. The scribe point on upper edge is located even with inner edge of guide to allow for minimum allowable gap. Locate trim lines for parts using skin scribe method as shown in figure 2 and substeps below:

(1) File edges of opening to be matched and edges of oversize part to remove all burrs.

(2) Place oversize part over opening and align any existing holes in part with their mating holes in structure. Install fasteners in several

existing full size holes. If part contains only pilot holes, undersize holes, or no holes, tape or hold part firmly in place.

(3) Loosen one untrimmed edge and insert skin scribe.

(4) Move scribe back and forth along edge of opening until visible line is produced on top surface of oversize part.

(5) Secure fastener or tape along marked edge and go to next edge. Repeat this procedure for each untrimmed edge.

(6) Remove part and trim edges.

b. **Tape Method.** Locating trim lines for oversize parts, where there is no access to back side for marking, may be done with masking tape as shown in figure 2 and substeps below:

(1) File edges of opening to be matched and edges of oversize part to remove all burrs.

(2) Align strips of masking tape along edges of opening to form frame.

(3) Put oversize part over opening and align any existing holes in part with their mating holes in structure. Install fasteners in as many of full size holes as possible. If part contains only pilot holes, undersize holes, or no holes, tape or hold part in place.

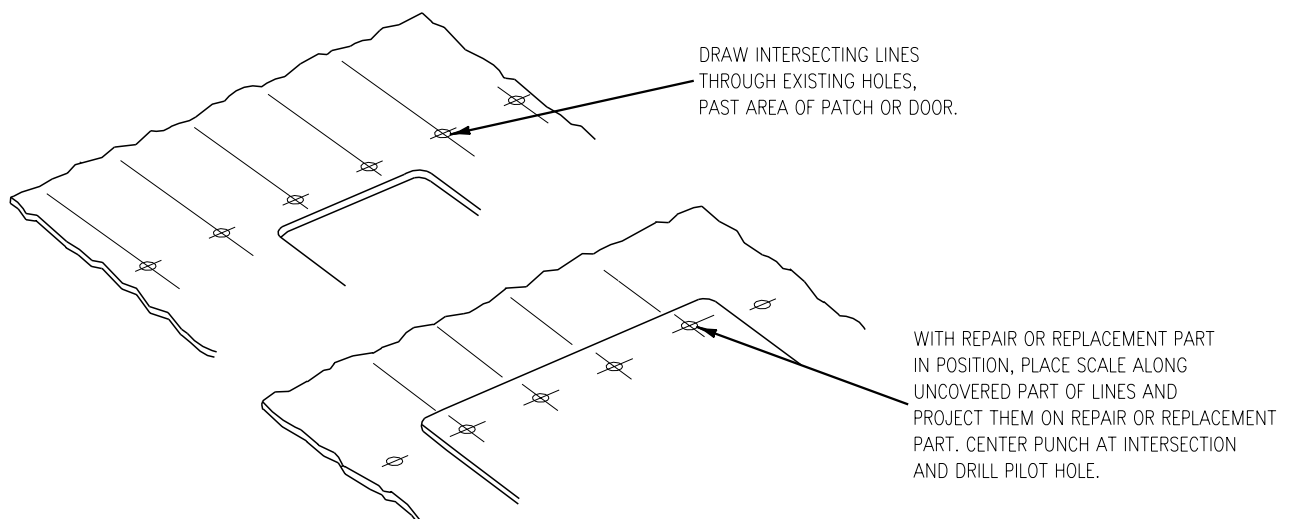
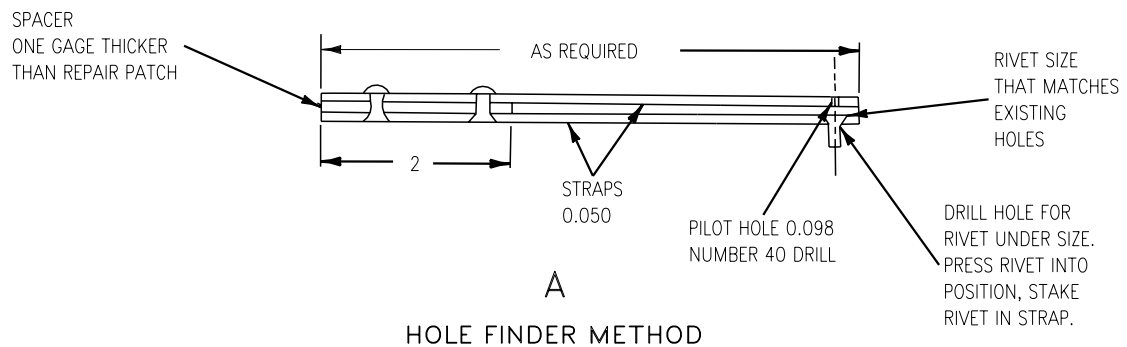
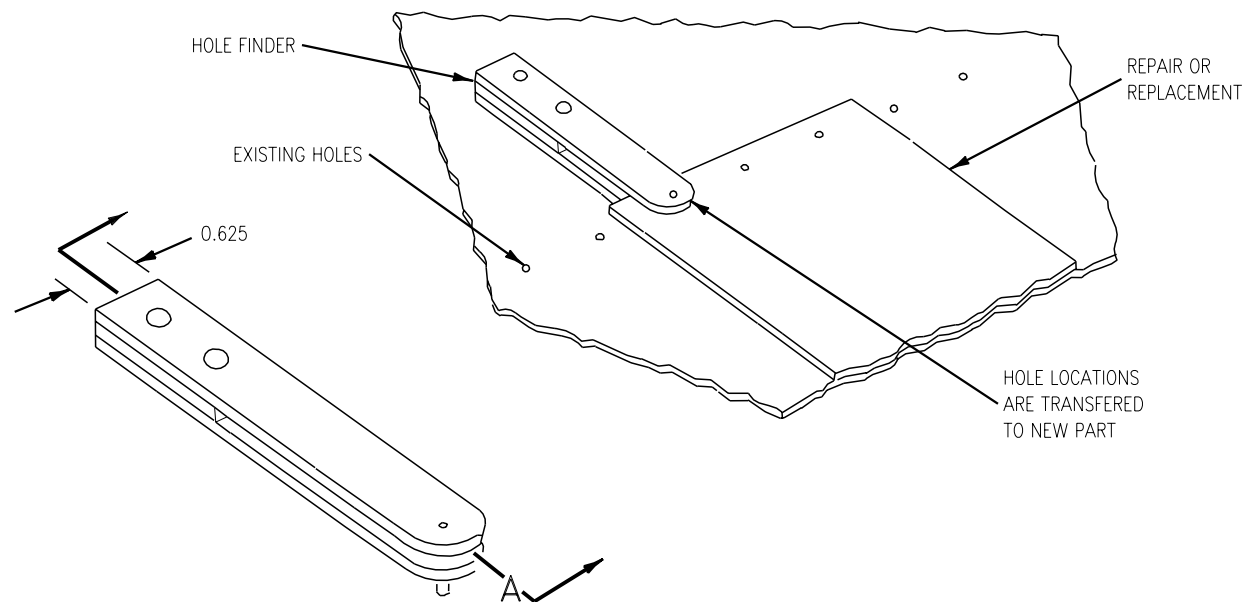
NOTE

When replacement part is thick, inner edge of second tape will fall short of matching edges of cutout causing new part to be large. Compensation for this mismatch can be made when marking edges.

(4) Carefully align outer edge of second strip of tape with outer edge of first strip of tape and pull it tightly up over oversize edge of part.

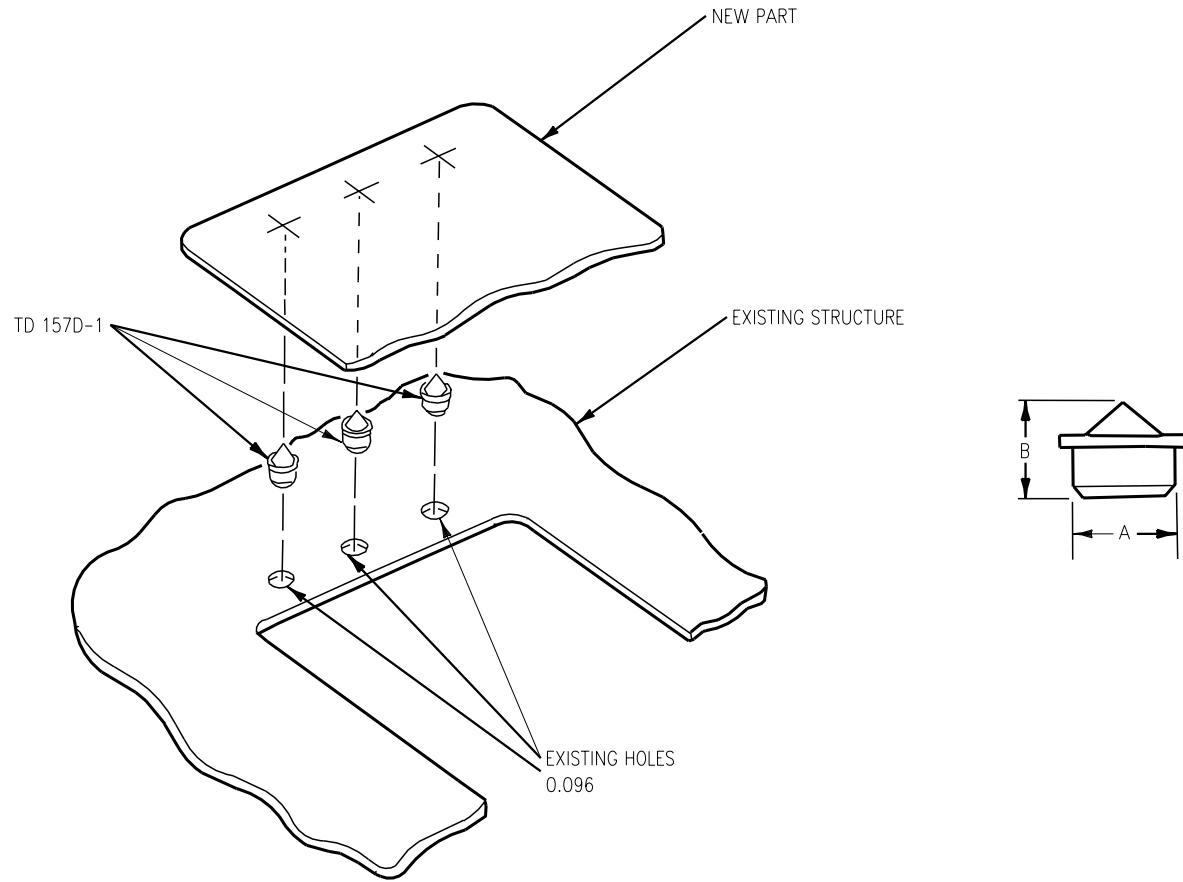
(5) Mark inside edge of second tape.

(6) Remove part and trim edges.



MEASURING AND SCALING METHOD

Figure 1. Locating Blind Holes (Sheet 1)

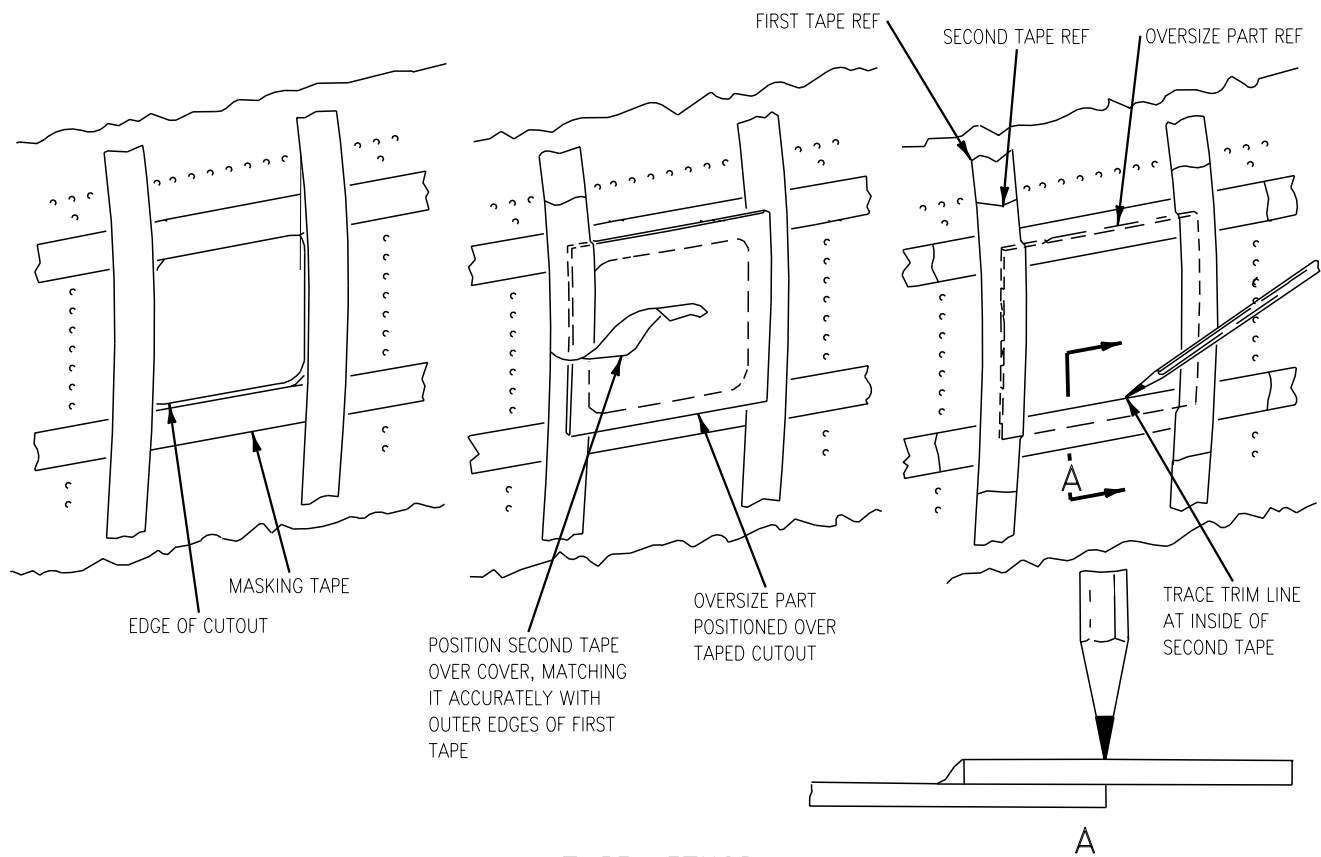


TOOL NO.	A	B
TD 157D-1	0.096	0.315
TD 157D-2	0.1265	0.315
TD 157D-3	0.157	0.315
TD 157D-4	0.1915	0.315
TD 157D-5	0.250	0.315
TD 157D-6	0.312	0.315
TD 157D-7	0.588	0.365
TD 157D-8	0.1875	0.315
TD 157D-9	0.250	0.250
TD 157D-10	0.312	0.250
TD 157D-11	0.186	0.250
TD 157D-12	0.238	0.313
TD 157D-13	0.245	0.313
TD 157D-14	0.253	0.313
TD 157D-15	0.303	0.375
TD 157D-16	0.308	0.375
TD 157D-17	0.370	0.438

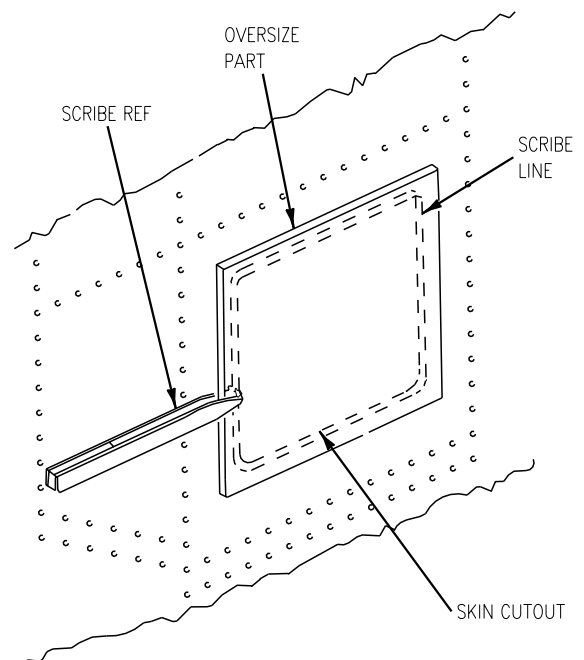
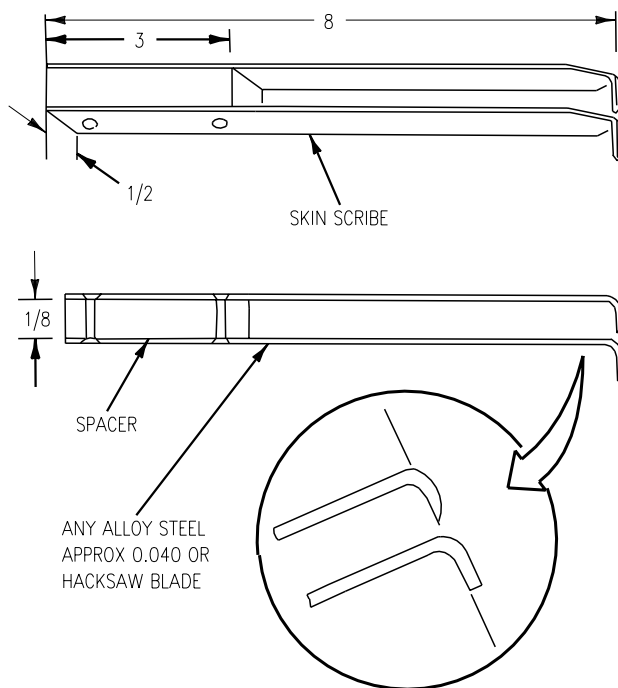
TOOL NO.	A	B
TD 157D-18	0.434	0.500
TD 157D-19	0.496	0.563
TD 157D-20	0.1240	0.315
TD 157D-21	0.1905	0.315
TD 157D-22	0.1865	0.315
TD 157D-23	0.165	0.315
TD 157D-24	0.1865	1.25
TD 157D-25	0.199	0.315
TD 157D-26	0.215	0.315
TD 157D-27	0.180	0.315
TD 157D-28	0.173	0.315
TD 157D-29	0.375	0.200
TD 157D-30	0.280	0.250
TD 157D-31	0.195	0.165
TD 157D-32	0.376	0.315
TD 157D-33	0.505	0.315

BLIND HOLE TRANSFER PUNCH METHOD

Figure 1. Locating Blind Holes (Sheet 2)



TAPE METHOD



SKIN SCRIBE METHOD

Figure 2. Locating Trim Lines

ORGANIZATIONAL MAINTENANCE

STRUCTURE REPAIR

SHOP PRACTICES

GANG CHANNEL AND PLATE NUT IDENTIFICATION AND REPAIR

Reference Material

Structure Repair, General Information	A1-F18AC-SRM-200
Repair Materials	WP007 00
Structural Hardware.....	NAVAIR 01-1A-8

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Plate Nut Removal	5
Plate Nuts With Permanently Installed Nuts.....	5
Plate Nuts With Removable Nuts.....	5

Record of Applicable Technical Directives

None

1. GANG CHANNELS.

2. Gang Channels are a series of equally spaced, self-locking nuts installed in a channel. They are attached to structure by rivets or bonded in position. For maintenance reasons, they may be considered as two types; gang channel assemblies with removable nuts and retainers, and gang channel assemblies with permanently installed nuts.

3. GANG CHANNEL ASSEMBLIES WITH REMOVABLE NUTS.

This type gang channel assembly made up of U-shaped channel, self-locking nuts, and retaining clips.

NOTE

Because tolerance buildup during manufacturing and assembly, a non-blueprint specified nut element may have been installed. A nut element of the same type as called out on the blueprint but with a counterbore depth (grip length) of 0.125 greater or less than the nut element specified on the drawing may have been used. To make sure the correct allowable fastener protrusion is maintained when replacement of a nut element is done, a grip length inspection of the replacement nut element should be done.

a. Part number identification of gang channel assemblies with removable nuts is shown in figure 1.

b. Part number identification of removable self-locking nut(s) is shown in figure 2. Basic McDonnell standard number of self-locking nut indicates type, temperature limitation, size, material, and counterbore depth. Nuts authorized for replacement have counterbore depth code number on ear of nut.

c. Nut replacement and gang channel retaining clip replacement, see figures 1 and 2.



Do not use self-locking nuts without code numeral on ear of nut, as stripped nuts and binding of screws will result.

NOTE

If nut was missing from channel, an inspection of channel should be made for cracked, bent, or broken section of channel. If channel is damaged, repair or replace per paragraph 4.

(1) Squeeze ends of retaining clip and remove clip.

(2) Remove nut from channel.

(3) Select new nut and position in channel.

(4) Squeeze ends of retaining clip and insert into slots in channel. For correct installation, see figure 1.

NOTE

Before removing gang channel with missing or damaged nuts, inspect to make sure nuts only, can not be replaced.

4. Gang Channel Assembly Repair or Replacement. Repair is done by cutting a gang channel section, of correct length, from standard gang channel assembly stock and splicing this section into area of removed or damaged channel. Standard stock sections are supplied in lengths of approximately 72 inches. For part number listing of gang channel stock (WP007 00).

Support Equipment Required

Part Number or Type Designation	Nomenclature
FABRICATE, FIGURE 3	Grip Gage

Materials Required

None



Be careful doing this step, make sure structure or other equipment are not damaged.

a. If splicing a section, cut out damaged channel allowing enough space after last good nut to maintain nut spacing.

b. Remove rivets which secure damaged channel section or whole channel to aircraft structure as below:

(1) Select correct twist drill size.

(2) Lightly point center of rivet head with rotating twist drill. Look at point mark to make sure it is approximately in center of rivet head. If point mark is not approximately centered, use twist drill to shift point mark in correct direction. A center punch may be used for pointing rivet center.

A1-F18AC-SRM-200

Change 6

004 05

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(3) Drill down through rivet head approximately through its height. See figure 3 and (NAVAIR 01-1A-8).



Support backside of structure to prevent damage when punching out drilled rivet.

(4) Using drift punch approximately 1/32 inch under twist drill size and held perpendicular to sheet surface, punch rivet shank out of hole,

shearing it from rivet head. In thick material, it may be required to drill down through rivet shank before driving it out. If this is required, use a twist drill 1/32 inch under rivet diameter.

(5) Use drift punch to pry remaining rivet head out of hole.



Do not use gang channel assemblies containing self-locking nuts without code numerical on ear of nut, as stripped nuts and binding screws will result.

c. Cut repair or replacement section from standard stock size gang channel. Allow enough space after last nut to maintain nut spacing when splicing into undamaged section.

d. Rivet replacement section to structure or if a repair splice is being made, rivet undamaged section to structure.

(1) Inspect rivet hole(s) for damage. Damaged hole(s) will required use of next size rivet.

(2) Select correct rivet. Use grip length gage manufactured per figure 3, to determine thickness of material.

(a) Rivets used to install gang channels are aluminum, MS20426AD, unless specified otherwise in specific structure repair manuals, A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750.

(b) Rivet diameter used to install gang channels with nut elements 1/4-inch diameter or less is 3/32; gang channels with nut elements larger than 1/4-inch require 1/8-inch rivets.

(c) Rivet length is computed using figure 3, table 1.

(3) Position gang channel.

(4) Drive rivets.

5. GANG CHANNEL ASSEMBLIES WITH PERMANENTLY INSTALLED NUTS. See figure 4. This type of gang channel has channel flanges bent over to retain nut. Nuts are not stocked separately as a replacement part.

a. Repair by Nut Replacement.

(1) Get standard stock gang channel (WP007 00).



Be careful when removing nut(s) or damage to channel may result.

(2) Spread flanges of spare gang channel and remove nut(s).

(3) Spread flanges of gang channel containing damaged nut(s) and remove nut(s).

(4) Install replacement nut(s).

(5) Close flanges of channel to hold nut(s) in position.

6. Gang Channel Repair or Replacement. Repair is done by cutting a gang channel section, of correct length, from standard gang channel assembly stock and splicing this section into area of removed or damaged channel. Standard stock sections are supplied in lengths of approximately 72 inches.

Support Equipment Required

Part Number or Type Designation	Nomenclature
FABRICATE, FIGURE 3	Grip Gage

Materials Required

None

a. If splicing a section, cut damaged channel allowing enough space after last good nut to maintain nut spacing.

b. Remove rivets which secure damaged channel section or whole channel to aircraft structure as below:

(1) Select correct twist drill size.

(2) Lightly point center of rivet head with rotating twist drill. Examine point mark to make sure it is approximately in center of rivet head. If point mark is not approximately centered, use twist drill to shift point mark in correct direction. A center punch may be used for pointing rivet center.

(3) Drill down through rivet head approximately through its height as shown in figure 3 and (NAVAIR 01-1A-8).



Support backside of structure to prevent damage when punching out drilled rivet.

(4) Using drift punch approximately 1/32 inch under twist drill size and held perpendicular to sheet surface, punch rivet shank out of hole, shearing it from rivet head. In thick material, it may be required to drill down through rivet shank before driving it out. If this is required, use a twist drill 1/32 inch under rivet diameter.

(5) Use drift punch to pry remaining rivet head out of hole.

c. Cut repair or replacement section from standard stock size gang channel. Allow enough space after last nut to maintain nut spacing when splicing into undamaged section.

d. Rivet replacement section to structure or if a repair splice is being made, rivet undamaged section to structure.

(1) Inspect rivet hole(s) for damage. Damaged hole(s) will require use of next size rivet.

(2) Select correct rivet. Use grip length gage, manufactured per figure 3, to determine thickness of material.

(a) Rivets used to install gang channel are aluminum, MS20426AD, unless specified otherwise in specific structure repair manuals, A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750.

(b) Rivet diameter used to install gang channels with nut elements 1/4-inch diameter or less is 3/32; gang channels with nut elements larger than 1/4-inch require 1/8-inch rivets.

(c) Rivet length is computed using figure 3, table 1.

(3) Position gang channel.

(4) Drive rivets.

7. BONDING GANG CHANNEL WITH ADHESIVE. See figure 5.

Support Equipment Required

NOTE

Alternate item type designations or part numbers are listed in parentheses.

Part Number or Type Designation	Nomenclature
MIL-V-21987	Vacuum Cleaner
—	Brush Nozzle, for Vacuum Cleaner
MODEL 12200 (12500)	Heat Gun

Materials Required

Specification or Part Number	Nomenclature
AA1048TY1CL1	Abrasive Cloth,
GRIT400X9X11	Aluminum Oxide
MIL-G-3866, TYPE 1	Mens Gloves, Cotton
OR TYPE 2,	Work Gloves
SMALL OR	
MEDIUM	
NO. 400	Fabricut, Wet-or-Dry, Sanding Screen

a. Aluminum alloys (clad and non-clad).

(1) Lightly abrade bond area(s) to satin finish with aluminum oxide abrasive cloth.

(2) Remove dust by vacuum cleaning with clean brush nozzle.



Make sure bonding material does not contact nut threads or floating nut area, damage to gang channel assembly may result.

NOTE

Handle bond area(s) with clean cotton work gloves.

(3) Prepare and apply bonding material specified in A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750.

b. Corrosion resistant steels.

(1) Scour bond area(s) with sanding screen and clean tap water.

(2) Rinse and dry excess water with heat gun.

(3) Air dry 30 minutes or force dry in oven for 10-15 minutes at 150° to 200°F where possible.



Make sure bonding material does not contact nut threads or floating nut area, damage to gang channel assembly may result.

NOTE

Handle bond area(s) with clean cotton work gloves.

(4) Prepare and apply bonding material specified in A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750.

8. GANG CHANNEL SHIMS. See figure 6. Gang channel shims are stored as optional length stock and cut to repair length when required.

a. Material:

P - Cotton base phenolic sheet.

D - Aluminum alloy, 2024-T3. C - Corrosion resistant steel.

K - Aluminum alloy, 6061-T6.

b. Length: Optional stock length is 48 inches. When 48 inch length is not enough for number of holes required, 2 pieces shall be used.

c. Installation: At least 2 rivets are required to hold each section, length, of shim to structure.

d. Phenolic shims are used where torque requirements are not critical.

e. To prevent corrosion 4M49 shims are specified to contact titanium.

f. Counterbored gang channel can be used without or with fewer shims.

9. PLATE NUTS.

10. Plate nuts are nut assemblies used for blind mounting in inaccessible locations and for ease of maintenance. Plate nuts are made in many sizes, shapes, and types; 1 or 2 lug, angled shapes, floating or non-floating nuts, and self-locking or plain nuts.

11. PLATE NUTS WITH REMOVABLE NUTS. This type plate nut assembly, has a retainer, nut element, and retaining clip, see figure 7. For nut element and retaining clip replacement, do steps below:

a. Squeeze ends of retaining clip and remove clip.

b. Remove nut element from retainer.

c. Select new nut.

d. Position nut element in retainer.

e. Squeeze ends of retaining clip and insert into slots of retainer. For correct installation, see figure 7.

12. PLATE NUTS WITH PERMANENTLY INSTALLED NUTS. This plate nut has a nut as the integral part of assembly and comes in floating and non-floating types. The plate nut is made for extended use and replaced if damaged, see figure 7.

13. PLATE NUT REMOVAL.

a. Select correct twist drill size.

b. Lightly point center of rivet head with rotating twist drill. Examine point mark to make sure it is approximately in center of rivet head. If point mark is not centered, use twist drill to shift point mark in correct direction. A center punch may be used for pointing rivet center.

c. Drill down through rivet head approximately through its height as shown in figure 3 and (NAVAIR 01-1A-8).



Support backside of structure to prevent damage when punching out drilled rivet.

d. Using drift punch approximately 1/32-inch under twist drill size and held perpendicular to sheet surface, punch rivet shank out of hole, shearing it from rivet head. In thick material, it may be required to drill down through rivet shank before driving it out. If this is required, use a twist drill 1/32-inch under rivet diameter.

e. Use drift punch to pry remaining rivet head out of hole.

14. PLATE NUT INSTALLATION.

Support Equipment Required

Part Number or Type Designation	Nomenclature
FABRICATE, FIGURE 3	Grip Gage

Materials Required

None

a. Inspect rivet hole(s) for damage. Damaged hole(s) will required use of oversize rivet.

b. Select correct rivet. Use grip length gage to determine thickness of material, see figure 3.

(1) Rivets used to install plate nuts are aluminum, MS20426AD, unless specified otherwise in specific structure repair manuals, A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750.

(2) Rivet diameter used to install plate nuts less than 1/4-inch diameter is 3/32; plate nuts larger than 1/4-inch require 1/8-inch rivets.

(3) Rivet length is computed using figure 3, table 1.

c. Position plate nut.

d. Drive rivets.

15. **BONDING PLATE NUTS WITH ADHESIVE.** See figure 5.

Support Equipment Required

Part Number or Type Designation	Nomenclature
MIL-V-21987	Vacuum Cleaner
-	Brush Nozzle, for Vacuum Cleaner
MODEL 12200 (12500)	Heat Gun

Materials Required

Specification or Part Number	Nomenclature
AA1048TY1CL1	Abrasive Cloth, Aluminum Oxide
GRIT400X9X11	
MIL-G-3866, TYPE 1	Mens Gloves, Cotton
OR TYPE 2,	Work Gloves
SMALL OR	
MEDIUM	
NO. 400	Fabricut, Wet-or-Dry, Sanding Screen

a. Aluminum alloys (clad and non-clad).

(1) Lightly abrade bond area(s) to satin finish with aluminum oxide abrasive cloth.

(2) Remove dust by vacuum cleaning with clean brush nozzle.



Make sure bonding material does not contact threads of nuts, or floating area of plate nut assembly, damage to plate nut assembly may result.

NOTE

Handle bond area(s) with clean cotton work gloves.

(3) Prepare and apply bonding material specified in A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750.

b. Corrosion resistant steels.

(1) Scour bond area(s) with sanding screen and clean tap water.

(2) Rinse and dry excess water with heat gun.

(3) Air dry 30 minutes or force dry in oven for 10-15 minutes at 150° to 200° F where possible.

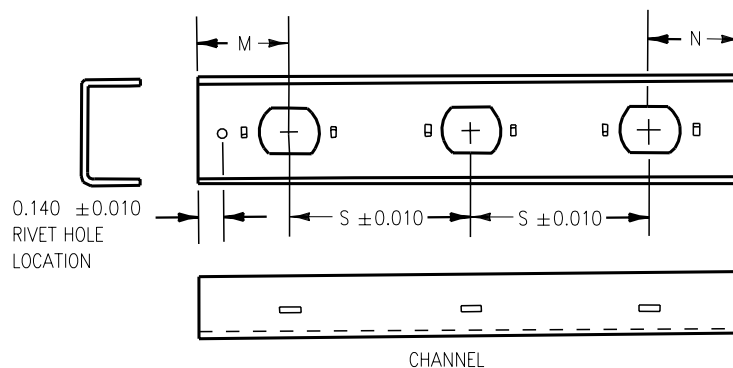
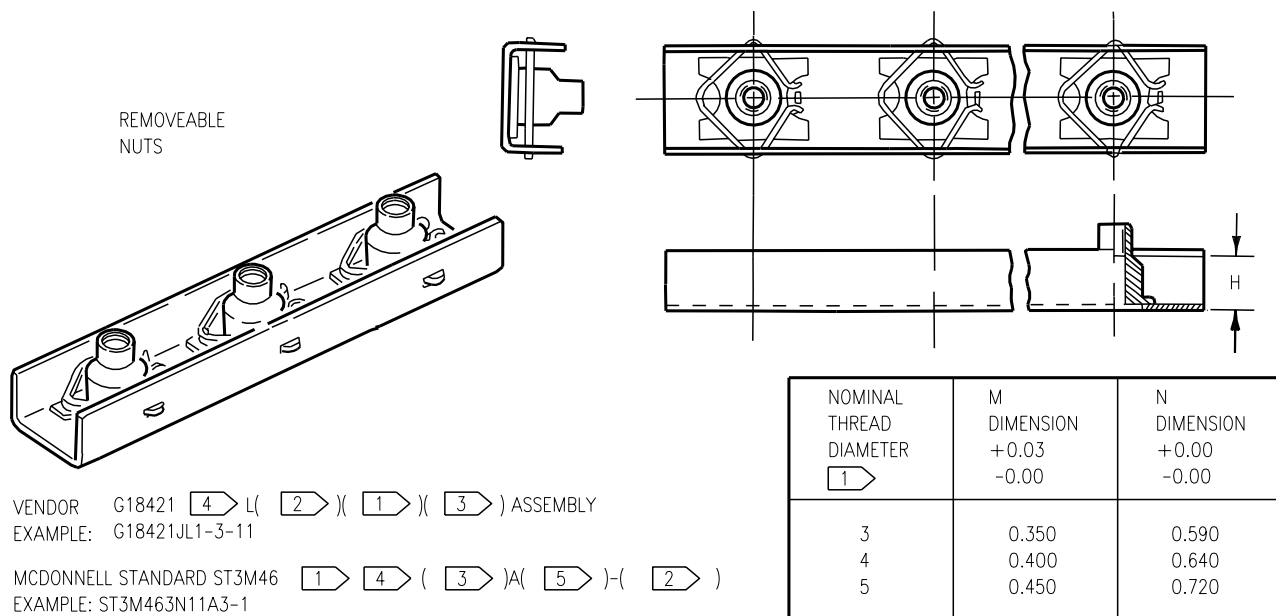


Make sure bonding material does not contact threads of nuts, or floating area of plate nut assembly, damage to plate nut assembly may result.

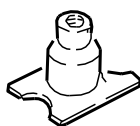
NOTE

Handle bond area(s) with clean cotton work gloves.

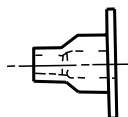
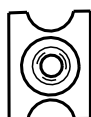
(4) Prepare and apply bonding material specified in A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750.



VENDOR NO.	MCDONNELL STANDARD NO.	THREAD OF NUT	NUT ELEMENT	CLIP
G18421L()-3	3M463C	0.190-32	G18421L()-3	9421B0
G18421L()-4	3M464C	0.250-28	G18421L()-4	9421B04
G18421L()-5	3M465C	0.3125-24	G18421L()-5	942105
G18421JL()-3	3M463N	0.190-32	G18421L()-3	9421B0
G18421JL()-4	3M464N	0.250-28	G18421L()-4	9421B04
G18421JL()-5	3M465N	0.3125-24	G18421L()-5	942105



G18421L NUT, SEE FIGURE 2



9421-(1) W CLIP



MATERIAL IS
CORROSION
RESISTANT STEEL

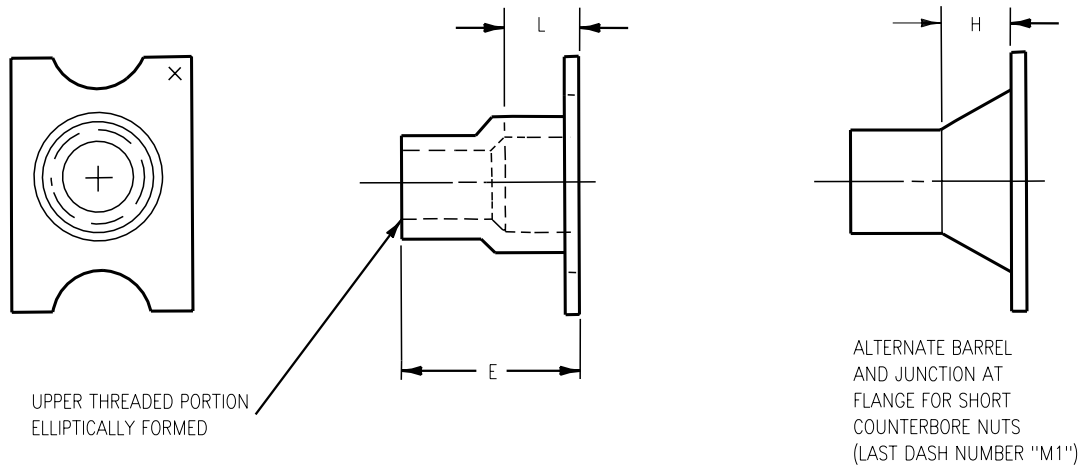
LEGEND

- 1 NORMAL THREAD DIAMETER OF NUTS (1/16 THS).
- 2 DEPTH OF COUNTERBORE IN ASSEMBLED NUTS. DIMENSION "H" (1/16 THS).
- 3 SPACING OF NUTS IN CHANNEL. DIMENSION "S" (1/8 THS).
- 4 LETTERS "J" OR "N" DESIGNATES ALUMINUM CHANNEL, LETTER "C" OR NO LETTER DESIGNATES CRES CHANNEL.
- 5 DESIGNATES NUMBER OF NUTS IN THE CHANNEL.

Figure 1. Gang Channel Identification G18421L

CAUTION

ONLY SELF-LOCKING NUTS WITH COUNTERBORE
DEPTH CODE NUMERAL ON EAR OF NUT SHALL
BE USED.



VENDOR PART NO.	MCDONNELL STANDARD NO.	THREAD	E MAX	H	L MIN
G18421L1-3	ST3M445C3M1	10-32	0.184	0.050	0.041
G18421L2-3	ST3M445C3M2		0.263	—	0.100
G18421L4-3	ST3M445C3M4		0.388	—	0.225
G18421L6-3	ST3M445C3M6		0.522	—	0.350
G18421L1-4	ST3M445C4M1	0.250-28	0.248	0.069	0.036
G18421L2-4	ST3M445C4M2		0.305	—	0.100
G18421L4-4	ST3M445C4M4		0.430	—	0.225
G18421L6-4	ST3M445C4M6		0.559	—	0.350
G18421L1-5	ST3M445C5M1	0.3125-24	0.287	0.061	0.036
G18421L2-5	ST3M445C5M2		0.344	—	0.100
G18421L4-5	ST3M445C5M4		0.480	—	0.225
G18421L6-5	ST3M445C5M6		0.605	—	0.350

BREAKDOWN OF
MCDONNELL STANDARD NO.

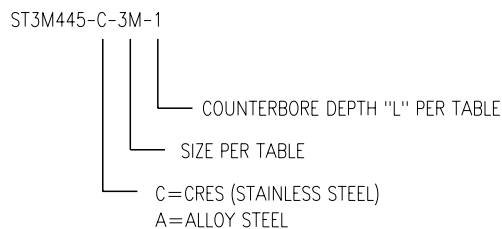


Figure 2. Gang Channel Self-Locking Nut Identification G18421L (ST3M445)

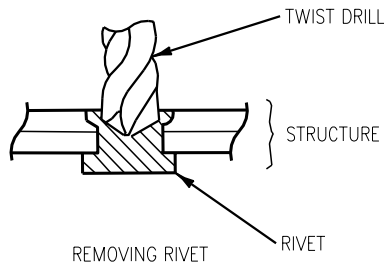
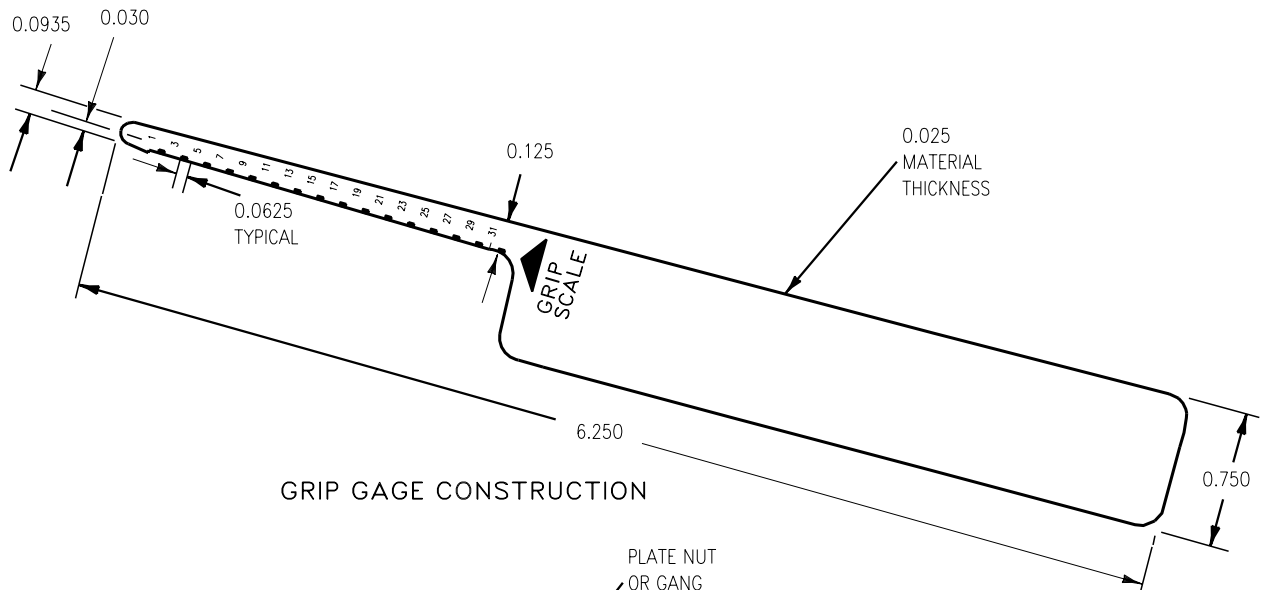


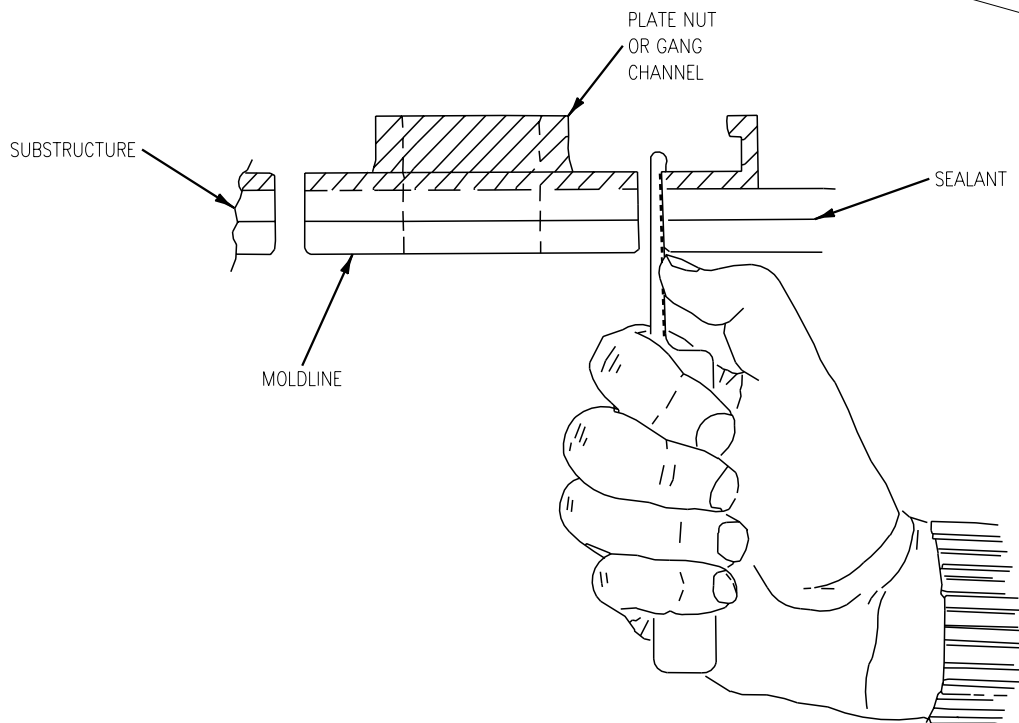
TABLE 1. COMPUTING CORRECT RIVET LENGTH

RIVET DIAMETER	MATERIAL THICKNESS	ADD
0.250 OR LESS	0.500 OR LESS	1 - 1/2 X DIAMETER

DRILLING OUT RIVETS

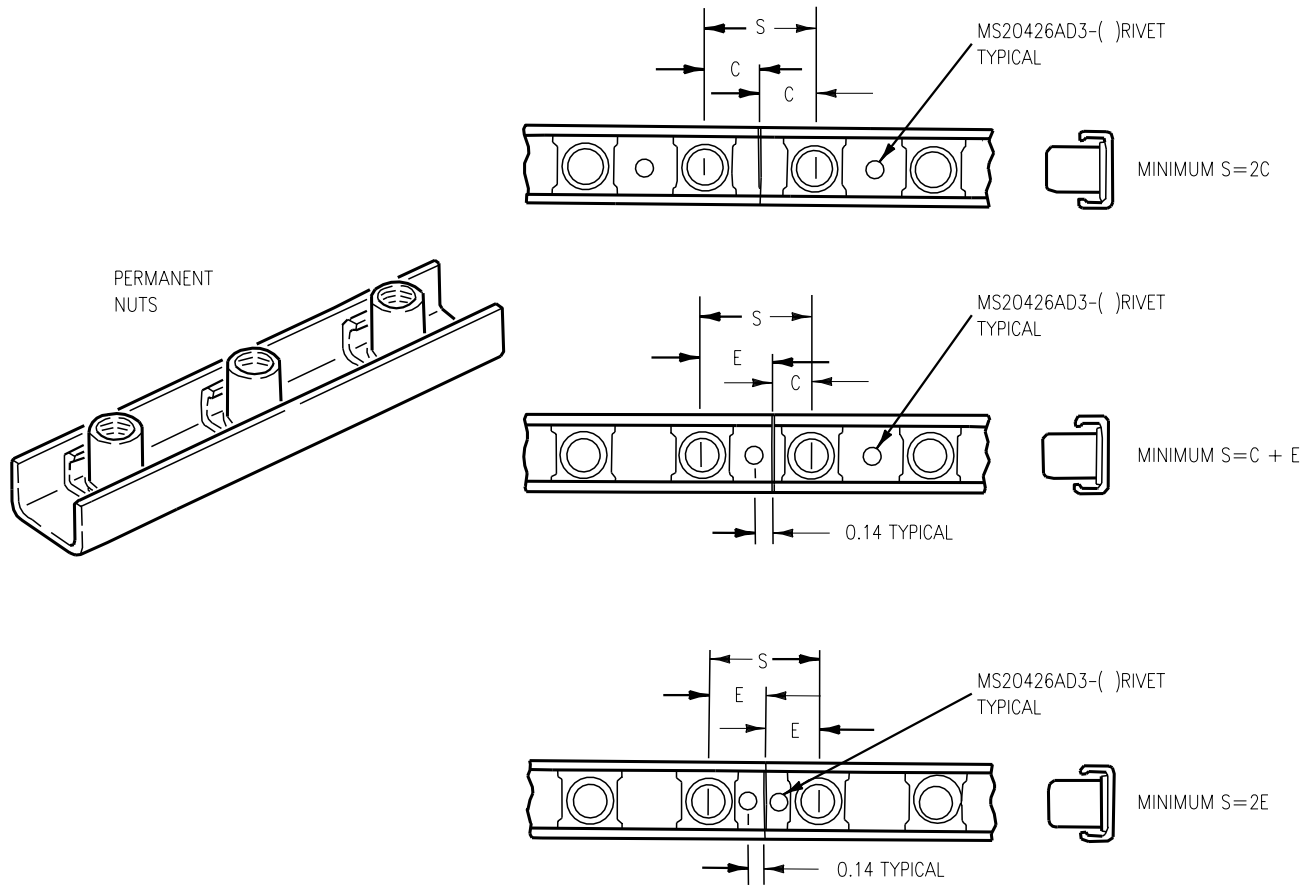


GRIP GAGE CONSTRUCTION



GRIP GAGE USE

Figure 3. Gang Channel and Plate Nut Removal and Installation

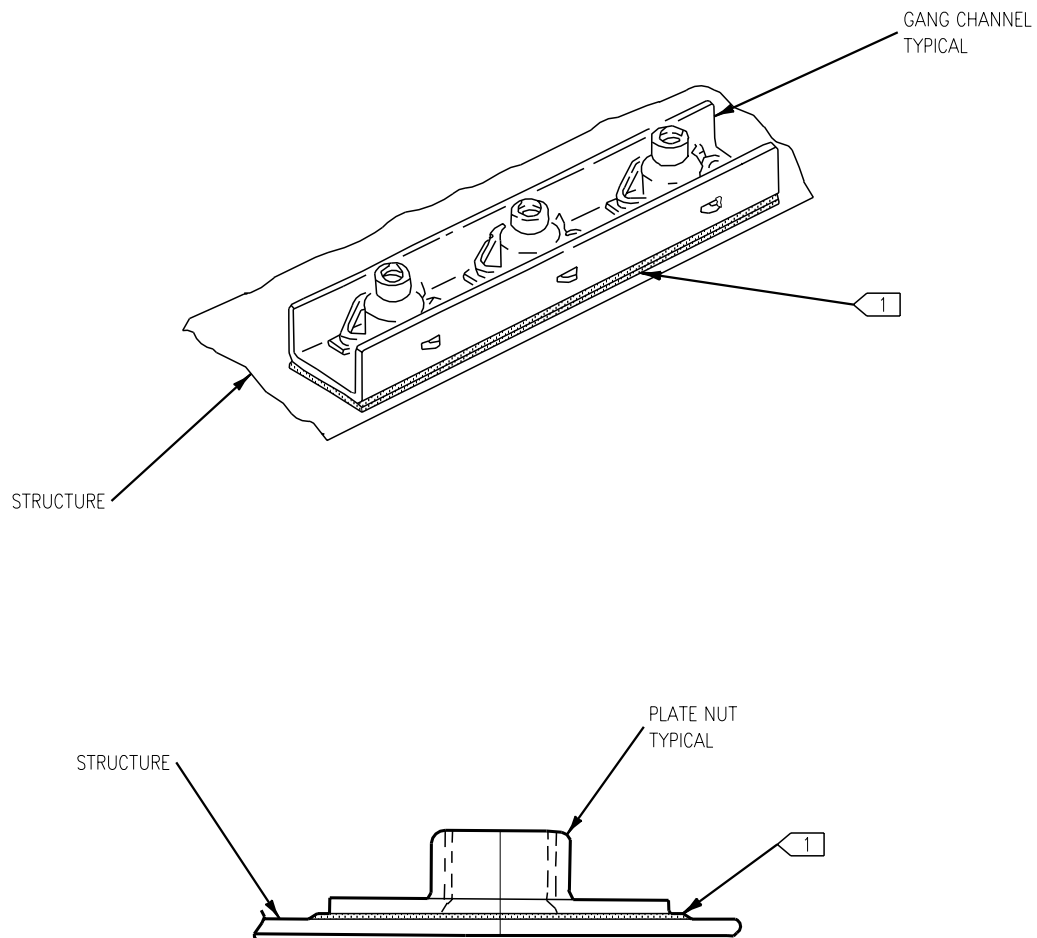


VENDOR PART NUMBER	MCDONNELL STANDARD NUMBER	NUT THREAD SIZE	END DIMENSIONS	
			C +0.03 -0.00	E +0.03 -0.00
G10851J3-9-3	3M448N3M9-3	10-32	0.350	0.590
G10851J3-10-5	3M448N3M10-5	10-32	0.350	0.590
G10851J3-10-6	3M448N3M10-6	10-32	0.350	0.590
G10851J3-10-9	3M448N3M10-9	10-32	0.350	0.590
G10851J3-11-3	3M448N3M11-3	10-32	0.350	0.590
G10851J4-8-2	3M448N4M8-2	1/4-28	0.400	0.640
G10851J4-10-5	3M448N4M10-5	1/4-28	0.400	-
G10851J4-10-7	3M448N4M10-7	1/4-28	0.400	0.640
G10851J4-11-3	3M448N4M11-3	1/4-28	0.400	0.640
G10851J4-12-2	3M448N4M12-2	1/4-28	0.400	0.640
G10851-3-9-6	3M448C3M9-6	10-32	0.350	0.590
G10851-3-10-4	3M448C3M10-4	10-32	0.350	0.590
G10851-3-10-5	3M448C3M10-5	10-32	0.350	0.590
G10851-3-10-5L	3M448C3M10-5L	10-32	0.350	0.590
G10851-3-10-7	3M448C3M10-7	10-32	0.350	0.590
G12093-2-3-12	ST3M723C2M12-13	10-32	0.350	0.590
G12093J2-3-8	ST3M723N2M3-8	10-32	0.350	0.590
G12093J2-3-9	ST3M723N2M3-9	10-32	0.350	0.590
G12093J2-3-10	ST3M723N2M3-10	10-32	0.350	0.590
G12093J2-4-8	ST3M723N2M4-8	10-32	0.350	0.590

Figure 4. Gang Channel Repair (Sheet 1)

VENDOR PART NUMBER	MCDONNELL STANDARD NUMBER	NUT THREAD SIZE	END DIMENSIONS	
			C +0.03 -0.00	E +0.03 -0.00
G12093J2-4-9	ST3M723N2M4-9	10-32	0.350	0.590
G12093J2-4-10	ST3M723N2M4-10	10-32	0.350	0.590
G12093J4-3-9	ST3M723N4M3-9	10-32	0.350	0.590
G12093J4-3-10	ST3M723N4M3-10	10-32	0.350	0.590
G12094J3-7	ST3M723N1M7	10-32	0.350	0.590
G12094J3-8	ST3M723N1M8	10-32	0.350	0.590
G12094J3-9	ST3M723N1M9	10-32	0.350	0.590
G12094J3-10	ST3M723N1M10	10-32	0.350	0.590
G12094J3-12	ST3M723N1M12	10-32	0.350	0.590
G12094J4-8	ST3M724N1M8	1/4-28	0.350	0.590
G12094J4-11	ST3M724N1M11	1/4-28	0.350	0.590
G12094J4-12	ST3M724N1M12	1/4-28	0.350	0.590
G49461-3-7-2F	3M448N3M7-2F	10-32	0.350	0.590
G49461-3-8-2F	3M448N3M8-2F	10-32	0.350	0.590
G49461-3-8-4	3M448N3M8-4	10-32	0.350	0.590
G49461-3-8-5	3M448N3M8-5	10-32	0.350	0.590
G49461-3-9-4	3M448N3M9-4	10-32	0.350	0.590
G49461-3-9-5	3M448N3M9-5	10-32	0.350	0.590
G49461-3-9-6	3M448N3M9-6	10-32	0.350	0.590
G49461-3-10-2F	3M448N3M10-2F	10-32	0.350	0.590
G49461-3-10-3	3M448N3M10-3	10-32	0.350	0.590
G49461-3-10-4	3M448N3M10-4	10-32	0.350	0.590
G49461-3-10-5	3M448N3M10-5	10-32	0.350	0.590
G49461-3-11-4	3M448N3M11-4	10-32	0.350	0.590
G49461-3-12-2F	3M448N3M12-2F	10-32	0.350	0.590
G49461-3-12-2L	3M448N3M12-2L	10-32	0.350	0.590
G49461-3-12-3	3M448N3M12-3	10-32	0.350	0.590
G49461-3-12-4	3M448N3M12-4	10-32	0.350	0.590
G40344-2-1-11	ST3M723N1M11	10-32	0.350	0.590
G50344-3-1-7	ST3M723N1M7	10-32	0.350	0.590
G50344-3-1-8	ST3M723N1M8	10-32	0.350	0.590
G50344-3-1-9	ST3M723N1M9	10-32	0.350	0.590
G50344-3-1-10	ST3M723N1M10	10-32	0.350	0.590
G50344-3-1-11	ST3M723N1M11	10-32	0.350	0.590
G50344-3-1-12	ST3M723N1M12	10-32	0.350	0.590
G50344-3-2-8	ST3M723N2M8	10-32	0.350	0.590
G50344-3-2-10	ST3M723N2M10	10-32	0.350	0.590
G50344-3-8-4	ST3M723N8M4	10-32	-	-
G50344-3-9-3	ST3M723N9M3	10-32	-	-
G50344-3-9-4	ST3M723N9M4	10-32	-	-
G50344-3-11-2	ST3M723N11M2	10-32	-	-
G50344-4-1-14	ST3M723N1M14	10-32	0.350	0.590
G50344-3-1-12	ST3M723C1M12	10-32	0.350	0.590
G50345-3-1-14	ST3M723C1M14	10-32	0.350	0.590
G50345-3-2-11	ST3M723C2M11	10-32	0.350	0.590
G50345-3-2-12	ST3M723C2M12	10-32	0.350	0.590
G50345-3-2-14	ST3M723C2M14	10-32	0.350	0.590
G50345-3-2-16	ST3M723C2M16	10-32	0.350	0.590
G51061-4-4	ST3M862N1M4-4	1/4-28	-	-
G51061-4-8	ST3M862N1M8-4	1/4-28	0.300	0.640
G51061-4-12	ST3M862N1M12-4	1/4-28	0.300	0.640
G51061-4-14	ST3M862N1M14-4	1/4-28	0.300	0.640
G51061-4-9	ST3M862N1M9-4	1/4-28	0.300	0.640
G51061-4-10	ST3M862N1M10-4	1/4-28	0.300	0.640
G51061-4-11	ST3M862N1M11-4	1/4-28	0.300	0.640

Figure 4. Gang Channel Repair (Sheet 2)



LEGEND

- 1 USE BONDING MATERIAL SPECIFIED IN A1-F18AC-SRM-210 THROUGH A1-F18AC-SRM-240 OR A1-F18AE-SRM-600 THROUGH A1-F18AE-SRM-750 SERIES MANUALS.

Figure 5. Bonding Gang Channel and Plate Nuts With Adhesive

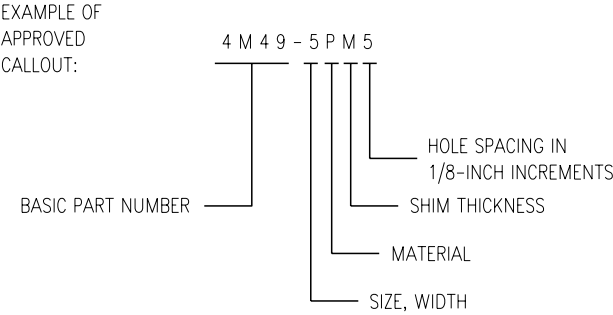
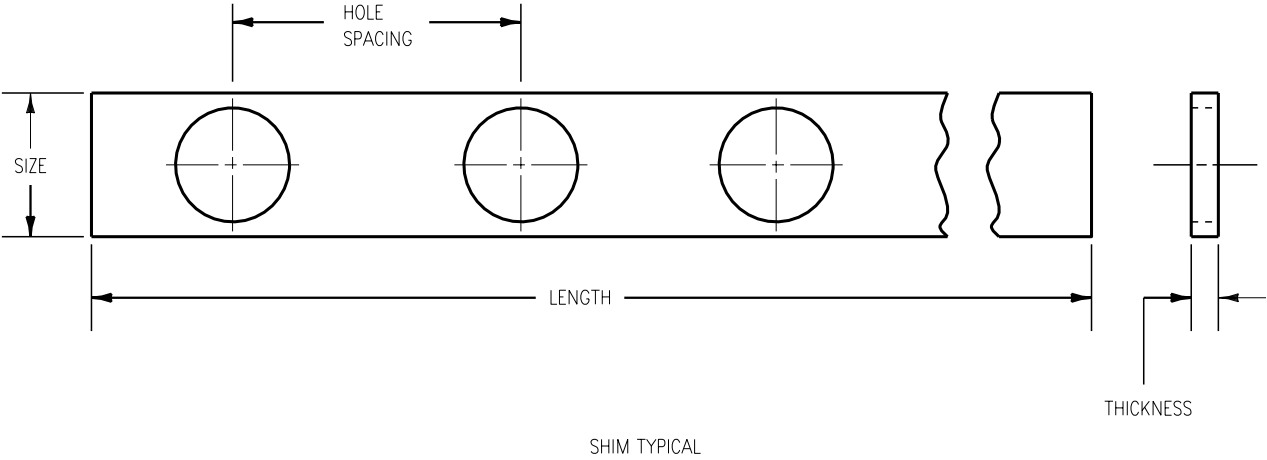
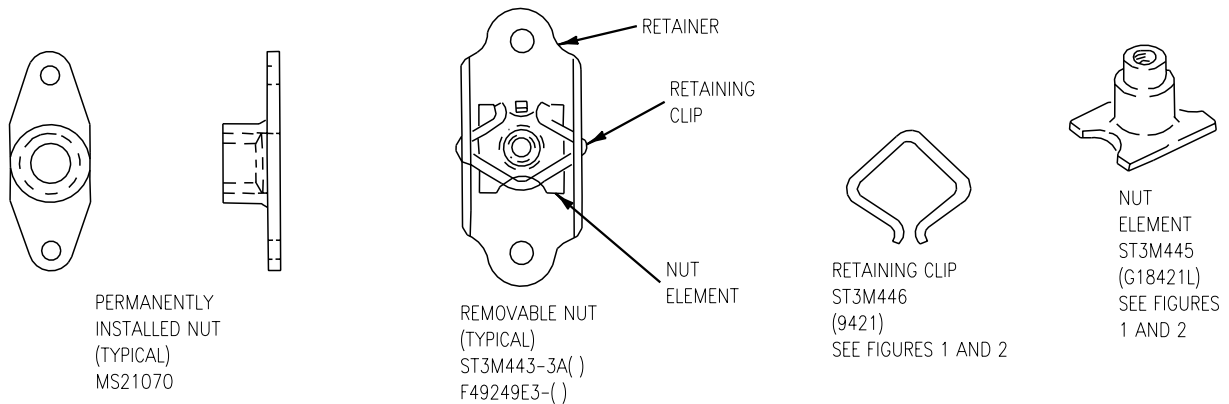


Figure 6. Gang Channel Shims



18AC-SRM-20-(38-1)31-SCAN

TABLE 1. PLATE NUTS WITH REMOVABLE NUTS.

ASSEMBLY	RETAINING CLIP	NUT ELEMENT
F49251E3-1 F49251E3-2 F49251E3-3 F49251E3-4 F49251E3-5 F49251E3-6	9421BO	G18421L1-3 G18421L2-3 G18421L3-3 G18421L4-3 G18421L5-3 G18421L6-3
F49251E4-1 F49251E4-2 F49251E4-3 F49251E4-4 F49251E4-5 F49251E4-6	9421BO4	G18421L1-4 G18421L2-4 G18421L3-4 G18421L4-4 G18421L5-4 G18421L6-4
F49251E5-1 F49251E5-2 F49251E5-3 F49251E5-4 F49251E5-5 F49251E5-6	9421BO5	G18421L1-5 G18421L2-5 G18421L3-5 G18421L4-5 G18421L5-5 G18421L6-5
F49249E3-1 F49249E3-2 F49249E3-3 F49249E3-4 F49249E3-5 F49249E3-6	9421BO	G18421L1-3 G18421L2-3 G18421L3-3 G18421L4-3 G18421L5-3 G18421L6-3
F49249E4-1 F49249E4-2 F49249E3-3 F49249E3-4 F49249E3-5 F49249E3-6	9421BO4	G18421L1-4 G18421L2-4 G18421L3-4 G18421L4-4 G18421L5-4 G18421L6-4
F49249E5-1 F49249E5-2 F49249E5-3 F49249E5-4 F49249E5-5 F49249E5-6	9421BO5	G18421L1-5 G18421L2-5 G18421L3-5 G18421L4-5 G18421L5-5 G18421L6-5
F49249E6-1 F49249E6-2	9421BO6	G18421L1-6 G18421L2-6

ASSEMBLY	RETAINING CLIP	NUT ELEMENT
F49249E7-1	K49300-7	G18421L1-7
F49069N3-1 F49069N3-2 F49069N3-4 F49069N3-6	9421BO	G18421L2-3 G18421L4-3 G18421L6-3
F49069N4-1 F49069N4-2 F49069N4-4 F49069N4-6	9421BO4	G18421L2-4 G18421L4-4 G18421L6-4
F49069N5-1 F49069N5-2 F49069N5-4 F49069N5-6	9421BO5	G18421L2-5 G18421L4-5 G18421L6-5
F39669N3-1 F39669N3-2 F39669N3-4 F39669N3-6	9421BO	-EM- G18421L2-3 G18421L4-3 G18421L6-3
F39669N4-1 F39669N4-2 F39669N4-4 F39669N4-6	9421BO4	G18421L2-4 G18421L4-4 G18421L6-4
F39669N5-1 F39669N5-2 F39669N5-4 F39669N5-6	9421BO5	G18421L2-5 G18421L4-5 G18421L6-5

TABLE 2. PLATE NUTS WITH PERMANENTLY INSTALLED NUT

PART NUMBER
F51827-3-2 F51827-3-16 F51827-4-10 F51827-4-13 F51827-4-23 F51827-4-25

Figure 7. Plate Nut Identification

ORGANIZATIONAL, INTERMEDIATE, AND DEPOT MAINTENANCE**STRUCTURE REPAIR****SHOP PRACTICES****FASTENERS**

Reference Material

Structural Hardware.....	NAVAIR 01-1A-8
Aircraft Corrosion Control.....	A1-F18AC-SRM-500
Priming Procedures	WP011 00
Finish System.....	WP012 00
Structure Repair, General Information	A1-F18AC-SRM-200
Gang Channel and Plate Nut Identification and Repair.....	WP004 05
Plane Captain Manual	A1-F18AC-PCM-000

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Lockbolts	8
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Record of Applicable Technical Directives

None

1. **DESCRIPTION.**

2. High performance aircraft require high strength fastener systems. This work package will supplement fastener information contained in (NAVAIR 01-1A-8). Fasteners may be replaced at organizational maintenance unless specified.

3. **HI-LOKS.** Hi-Loks are threaded pin and collar fasteners. Fasteners are available in either flush or protruding head styles. Threaded end contains hexagon shaped recess which engages hex, allen wrench. Hex wrench prevents rotation of Hi-Lok while collar is being installed. Collar is designed with wrenching device that separates at torque off groove when predetermined torque is reached. This produces permanent type of installation, collar cannot be removed as nut can. Because of collar break off at designed preload, torque inspection after installation is not required.

4. **Identification.** Identified by standard code number which represents type, style, nominal diameter, and grip range. See figure 1 for breakdown of code number. Diameter is measured in 1/32-inch increments and grip length in 1/16-inch increments. Hi-Loks are available in titanium and corrosion resistant steel, see table 1. Titanium alloy used where temperatures are below 600° F. Corrosion resistant steel used where temperatures range from 600° to 1200° F. Ultimate shear strength of titanium is 95,000 psi and CRES is 125,000 psi. Collar materials are identified by color code: 2024-T6, orange; A286, black. Collars SW2000 CRES, and HL582-5MCA, aluminum, are self-aligning and must be used with washer. This washer collar combination will accommodate maximum of 8 degrees misalignment.

Table 1. Hi-Lok Fasteners

HI-LOK NUMBER	MATERIAL	TYPE HEAD
HLT265TB8-()-()	CRES	Flush Tension
HLT265TB10-()-()	CRES	Flush Tension
HLT265TB12-()-()	CRES	Flush Tension
HLT265TB14-()-()	CRES	Flush Tension
HLT51()5-()	CRES	Crown Shear
HLT311()5-()	Titanium	Crown Shear
HLT311-5-()	Titanium	Crown Shear
HLT51()6-()	CRES	Crown Shear
HLT311()6-()	Titanium	Crown Shear
HLT311-6-()	Titanium	Crown Shear
HLT51()8-()	CRES	Crown Shear
HLT311()8-()	Titanium	Crown Shear

Table 1. Hi-Lok Fasteners (Continued)

HI-LOK NUMBER	MATERIAL	TYPE HEAD
HLT311-8-()	Titanium	Crown Shear
HLT51()10-()	CRES	Crown Shear
HLT311()10-()	Titanium	Crown Shear
HLT311-10-()	Titanium	Crown Shear
HLT51()12-()	CRES	Crown Shear
HLT311()12-()	Titanium	Crown Shear
HLT311-12-()	Titanium	Crown Shear
HLT51()14-()	CRES	Crown Shear
HLT311()14-()	Titanium	Crown Shear
HLT311-14-()	Titanium	Crown Shear
HLT50()5-()	CRES	Protruding Shear
HLT310()5-()	Titanium	Protruding Shear
HLT310-5-()	Titanium	Protruding Shear
HLT50()6-()	CRES	Protruding Shear
HLT310()6-()	Titanium	Protruding Shear
HLT310-6-()	Titanium	Protruding Shear
HLT50()8-()	CRES	Protruding Shear
HLT310()8-()	Titanium	Protruding Shear
HLT310-8-()	Titanium	Protruding Shear
HLT50()10-()	CRES	Protruding Shear
HLT310()10-()	Titanium	Protruding Shear
HLT310-10-()	Titanium	Protruding Shear
HLT50()12-()	CRES	Protruding Shear
HLT310()12-()	Titanium	Protruding Shear
HLT310-12-()	Titanium	Protruding Shear

Table 1. Hi-Lok Fasteners (Continued)

HI-LOK NUMBER	MATERIAL	TYPE HEAD
HLT313()5-()	Titanium	Crown Tension
HLT313-5-()	Titanium	Crown Tension
HLT53()6-()	CRES	Crown Tension
HLT313()6-()	Titanium	Crown Tension
HLT313-6-()	Titanium	Crown Tension
HLT53()8-()	CRES	Crown Tension
HLT313()8-()	Titanium	Crown Tension
HLT313-8-()	Titanium	Crown Tension
HLT53()10-()	CRES	Crown Tension
HLT313()10-()	Titanium	Crown Tension
HLT313-10-()	Titanium	Crown Tension
HLT53()12-()	CRES	Crown Tension
HLT313()12-()	Titanium	Crown Tension
HLT313-12-()	Titanium	Crown Tension
HLT53()14-()	CRES	Crown Tension
HLT313()14-()	Titanium	Crown Tension
HLT313-14-()	Titanium	Crown Tension
HLT52()5-()	CRES	Protruding Tension
HLT312()5-()	Titanium	Protruding Tension
HLT312-5-()	Titanium	Protruding Tension
HLT52()6-()	CRES	Protruding Tension
HLT312()6-()	Titanium	Protruding Tension
HLT312-6-()	Titanium	Protruding Tension
HLT52()8-()	CRES	Protruding Tension
HLT312()8-()	Titanium	Protruding Tension

Table 1. Hi-Lok Fasteners (Continued)

HI-LOK NUMBER	MATERIAL	TYPE HEAD
HLT312-8-()	Titanium	Protruding Tension
HLT52()10-()	CRES	Protruding Tension
HLT312()10-()	Titanium	Protruding Tension
HLT312-10-()	Titanium	Protruding Tension
HLT52()12-()	CRES	Protruding Tension
HLT312()12-()	Titanium	Protruding Tension
HLT312-12-()	Titanium	Protruding Tension

5. Requirements.

a. Minimum edge distance for flush and protruding head Hi-Loks is two times the diameter being installed plus 0.03 inch, or as specified in specific repair procedure or when replacing existing Hi-Loks.

b. Spacing is measured between centerlines. Minimum spacing shall be as specified in specific repair procedure except when replacing existing Hi-Loks.

c. For Hi-Lok hole sizes, see table 2.

(1) Class 1 hole sizes are usually selected where relative movement of the joined parts is undesirable.

(2) Class 2 hole sizes are usually selected where moderate installation clearances are desirable and some movement is allowable.

(3) Interference fit hole sizes allows no movement of joined parts.

d. For Hi-Lok grip length, see table 3.

Table 2. Hi-Lok Hole Sizes

HI-LOK Diameter	Hole Size		
	Class I	Class 2	Interference Fit
5/32 (08)	0.1635 +0.0015 -0.0007	0.1635 +0.0025 -0.0000	0.1600 +0.0025 -0.0000
3/16 (3)	0.1895 +0.0015 -0.0007	0.1895 +0.0025 -0.0000	0.1850 +0.0030 -0.0000
1/4 (4)	0.2495 +0.0015 -0.0007	0.2495 +0.0025 -0.0000	0.2450 +0.0030 -0.0000
5/16 (5)	0.3120 +0.0015 -0.0007	0.3120 +0.0020 -0.0000	0.3075 +0.0030 -0.0000
3/8 (6)	0.3745 +0.0015 -0.0007	0.3745 +0.0020 -0.0000	0.3700 +0.0030 -0.0000
7/16 (7)		0.4370 +0.0020 -0.0000	0.4325 +0.0030 -0.0000

Table 3. Hi-Lok Grip Length

DASH NO.	GRIP LENGTH (MAXIMUM)	MATERIAL THICKNESS
2	0.125	0.063 - 0.125
3	0.188	0.126 - 0.188
4	0.250	0.189 - 0.250
5	0.312	0.251 - 0.312
6	0.375	0.313 - 0.375
7	0.438	0.376 - 0.438
8	0.500	0.439 - 0.500
9	0.562	0.501 - 0.562
10	0.625	0.563 - 0.625
11	0.688	0.626 - 0.688
12	0.750	0.689 - 0.750
13	0.812	0.751 - 0.812
14	0.875	0.813 - 0.875
15	0.938	0.876 - 0.938
16	1.000	0.939 - 1.000
17	1.062	1.001 - 1.062
18	1.125	1.063 - 1.125
19	1.188	1.126 - 1.188
20	1.250	1.189 - 1.250
21	1.312	1.251 - 1.312
22	1.375	1.313 - 1.375
23	1.438	1.376 - 1.438
24	1.500	1.439 - 1.500
25	1.562	1.501 - 1.562
26	1.625	1.563 - 1.625

Table 3. Hi-Lok Grip Length (Continued)

DASH NO.	GRIP LENGTH (MAXIMUM)	MATERIAL THICKNESS
27	1.688	1.626 - 1.688
28	1.750	1.689 - 1.750
29	1.812	1.751 - 1.812
30	1.875	1.813 - 1.875
31	1.938	1.876 - 1.938
32	2.000	1.939 - 2.000
33	2.062	2.001 - 2.062
34	2.125	2.063 - 2.125
35	2.188	2.126 - 2.188
36	2.250	2.189 - 2.250
37	2.312	2.251 - 2.312
38	2.375	2.313 - 2.375

6. **Removal.** See figure 2. Hi-Lok fasteners may be removed by holding pin with an allen wrench and turning the collar with pliers. Undamaged pins may be reused, any collar that has been removed shall be scrapped. Pins installed in interference holes shall be driven out with a plastic mallet or by driving with a light hitting rivet gun. Back up structure to prevent damage before driving out the fastener.

Materials Required

None

7. **Installation.** Install Hi-Loks using tools listed below, and shown in figure 2:

HLH127 Ratchet Wrench Assembly
 HLH110 Hand Tool Assembly
 HLH103 Hand Tool Assembly
 HLH104 Hand Tool Assembly

Support Equipment Required

Part Number or Type Designation

Nomenclature

HLH127	Hi-Lok/Hi-Tigue Hand Tool Ratchet Wrench Assembly
HLH110	Hi-Lok/Hi-Tigue Hand Tool Assembly
HLH103	Hi-Lok/Hi-Tigue Hand Tool Assembly
HLH104	Hi-Lok/Hi-Tigue Hand Tool Assembly

a. Parts to be joined shall be secured firmly in position.

b. Install in hole and inspect head for correct seating.



Use a phenolic rod between fastener head and mallet, damage to skin/structure may occur.

Do not use a rivet gun on composite joints or where vibration driving is not allowed, damage to composite may occur.

c. In interference fit or class 1 holes, pin must be driven through hole until head is seated before installing collar. Pins may be driven by tapping head with a plastic mallet or by driving with a light hitting rivet gun. Back up structure while seating fastener.

d. Inspect pin thread protrusion through hole per figure 2.

NOTE

When washers are used, pin thread protrusion limits are measured from washer surface.

e. Washers may be used under collar to meet pin protrusion limits as below:

(1) The maximum total washer thickness shall be 0.032 inch and maximum number of washers used shall be one, except when 0.016 inch thick washers are used, then two may be used.



Use washers per substep (2), (3), or (4).
Use of wrong washer will cause corrosion.

(2) Use only corrosion resistant steel washers on Hi-Loks with corrosion resistant steel collars except when structure on which washer will seat is aluminum; washer shall also be aluminum.

(3) Use only aluminum washers on pins with aluminum collars.

(4) Use only corrosion resistant steel washers on lockbolts with corrosion resistant steel or monel collars.

f. Hi-Lok fasteners may be installed through wet sealant and sealant material need not be

removed from threads if collar is installed while sealant is wet.

g. Start collar on threads a minimum 3/4 turn by hand.

h. After collar has been started, power or hand tools may be used to install collar.

i. Correct torque is achieved when wrenching device twists off pin.

8. **Inspection.** Final inspection of pin protrusion will be as shown in figure 2, step 5, and below:

a. No interface gap is allowed at shank of pin.

b. Loose Hi-Loks that can be moved axially or rotated with fingers are not allowed and must be replaced.

c. Gaps under Hi-Lok heads are allowable:

(1) When 0.004 inch or less.

(2) When no more than 40 percent of circumference has a gap.

d. Replace Hi-Loks, if a 0.005 inch feeler gage can be inserted to shank, see figure 3.

e. No collar shall have wrench marks or cuts showing evidence of being reinstalled or retightened after installation.

f. No gaps are allowed under collar.

9. **LOCKBOLTS.** Lockbolts are made up of a grooved pin and a tubular collar which is swaged into grooves of pin. Lockbolts are available in protruding head and 100 degree flush head styles. Two types of lockbolts are used: stump type, driven with standard riveting equipment except for special sets used for swaging collars; and pull gun type, has a pulling stem which breaks off as pulling gun pulls lockbolt and swages collar into locking grooves of lockbolt. Lockbolts are available in corrosion resistant steel and titanium alloy materials.

10. **Identification.** Lockbolts are identified by basic part number which represents type, nominal diameter, and grip length. See figure 4 for basic part numbers and types. Diameter is measured in 1/32 inch increments. Grip length for shear head is maximum material thickness lockbolt will

accommodate measured in 1/16 inch increments. A 2605V5 would be protruding head titanium lockbolt, nominal diameter is 5/32 inch, and maximum grip length is 5/16 inch. Collars, which are swaged into grooves of lockbolts are identified by basic part

number and dash number which corresponds to nominal diameter. See figure 4 for collar part numbers. Collars are also identified by color code for different types of materials as shown in table 4.

Table 4. Lockbolt Collars

FASTENER STYLE	PART NUMBER	NOMINAL PIN DIA.	MATERIAL	COLOR
SHEAR TYPE	NAS1080AG05	5/32	2219-T6	VIOLET
	NAS1080AG06	3/16		
	NAS1080AG08	1/4		
	NAS1080AG10	5/16		
	NAS1080AG12	3/8		
	NAS1080MG05	5/32	MONEL (400)	BLACK
	NAS1080MK06	3/16		
	NAS1080MK08	1/4		
	NAS1080MK10	5/16		
	NAS1080MK12	3/8		
TENSION TYPE	NAS1080-06	3/16	2024-T4	GREEN
	NAS1080-08	1/4		
	NAS1080 P 10	5/16	2024-T4	BLUE
	NAS1080 P 12	3/8		

11. Requirements.

a. Edge distance is measured from lockbolt centerline to nearest edge of part. Minimum edge distance for flush and protruding head lockbolts is two times nominal diameter plus 0.03 inch, except where specified in a specific repair procedure or when replacing existing lockbolts.

b. Spacing is measured between centerline of lockbolts. Minimum spacing shall be as specified in specific repair procedure except when replacing existing lockbolts.

c. Lockbolt grip length, see table 5.

d. Hole sizes for titanium lockbolts, see table 6.

Table 5. Lockbolt Grip Length

DASH NO.	MATERIAL THICKNESS	
	SHEAR HEAD	TENSION HEAD
1	0.020 - 0.062	0.031 - 0.094
2	0.063 - 0.125	0.095 - 0.156
3	0.126 - 0.188	0.157 - 0.219
4	0.189 - 0.250	0.220 - 0.281
5	0.251 - 0.312	0.282 - 0.344

Table 5. Lockbolt Grip Length (Continued)

DASH NO.	MATERIAL THICKNESS	
	SHEAR HEAD	TENSION HEAD
6	0.313 - 0.375	0.345 - 0.406
7	0.376 - 0.438	0.407 - 0.469
8	0.439 - 0.500	0.470 - 0.531
9	0.501 - 0.562	0.532 - 0.594
10	0.563 - 0.625	0.595 - 0.656
11	0.626 - 0.688	0.657 - 0.719
12	0.689 - 0.750	0.720 - 0.781
13	0.751 - 0.812	0.782 - 0.844
14	0.813 - 0.875	0.845 - 0.906
15	0.876 - 0.938	0.907 - 0.969
16	0.939 - 1.000	0.970 - 1.031
17	1.001 - 1.062	1.032 - 1.094
18	1.063 - 1.125	1.095 - 1.156
19	1.126 - 1.188	1.157 - 1.219
20	1.189 - 1.250	1.220 - 1.281
21	1.251 - 1.312	1.282 - 1.344
22	1.313 - 1.375	1.345 - 1.406
23	1.376 - 1.438	1.407 - 1.469
24	1.439 - 1.500	1.470 - 1.531
25	1.501 - 1.562	1.532 - 1.594
26	1.563 - 1.625	1.595 - 1.656
27	1.626 - 1.688	1.657 - 1.719
28	1.689 - 1.750	1.720 - 1.781
29	1.751 - 1.812	1.782 - 1.844

Table 5. Lockbolt Grip Length (Continued)

DASH NO.	MATERIAL THICKNESS	
	SHEAR HEAD	TENSION HEAD
30	1.813 - 1.875	1.845 - 1.906
31	1.876 - 1.938	1.907 - 1.969
32	1.939 - 2.000	1.970 - 2.031



Do not strike structure with chisel when splitting lockbolt collar. Damage may result.

Support Equipment Required

**Part Number or
Type Designation**

Nomenclature

NSN Group 5210

Feeler Gage

12. Removal. Remove by splitting collar axially with lockbolt collar splitter or by splitting collar with chisel. A special hollow end mill in a drill motor may also be used to remove collar. After collar is removed, drive out pin with punch. When removing from thin material, back up structure to prevent damage.

Materials Required

None

13. Installation. See figure 5.

a. Parts to be joined shall be secured firmly into position.

b. Holes should be reamed to final hole size per table 6.

Table 6. Hole Sizes For Titanium Lockbolts

LOCKBOLT SIZE	CLASS 1 FIT	CLASS 2 FIT	Interference FIT
5/32	0.1628 +0.0022 -0.0000	0.1635 +0.0025 -0.0000	0.1600 +0.0025 -0.0000
3/16	0.1888 +0.0022 -0.0000	0.1895 +0.0025 -0.0000	0.1850 +0.0030 -0.0000
1/4	0.2488 +0.0022 -0.0000	0.2495 +0.0025 -0.0000	0.2450 +0.0030 -0.0000
5/16	0.3113 +0.0022 -0.0000	0.3120 +0.0025 -0.0000	0.3075 +0.0030 -0.0000
3/8	0.3738 +0.0022 -0.0000	0.3745 +0.0025 -0.0000	0.3700 +0.0030 -0.0000

c. Select correct diameter and length for thickness of material to be joined.

d. Grip length may be adjusted using one length longer or shorter or by installing washers under collar. Maximum total washer thickness shall

be 0.032 inch and maximum number of washers used shall be one, except when 0.016 inch thick washer are used, then two may be used.

NOTE

If pin is installed wet with sealant, all sealant must be removed from pin groove before installing collar.

e. Install stump type lockbolts by using a special collar set in a rivet gun and bucking bar. The set is positioned on collar and bucking bar positioned against head of lockbolt. Collar is swaged onto locking grooves of lockbolt. Back up structure or flanges when installing stump type lockbolts.

f. Installing pull type lockbolts is a continuous operation using a pulling gun. Lockbolt is installed in hole and collar positioned on grooved end of lockbolt. Pulling gun is installed on grooved end. Gun is actuated, lockbolt is pulled into hole, and collar is swaged onto locking grooves by anvil of gun. Continuous buildup of pressure by gun automatically breaks lockbolt at break neck grooves.

g. After installing pull type lockbolts, apply corrosion preventive compound to stem break off area.

14. **Inspection.** Lockbolt heads and collars shall be inspected for looseness and gap. Lockbolts found to be loose will be removed and replaced. Gaps under head of either protruding or flush head which shall allow insertion of 0.005 inch feeler gage to shank are bad. Gaps which will allow insertion of 0.004 inch feeler gage are allowed provided no more than 40 percent of head circumference has a gap. Collars will be visually inspected with feeler gage to make sure collars are being completely swaged, see figure 6, inspection criteria for collars.

15. **TAPER-LOKS.** See figure 7. Installation of taper-loks is depot maintenance. The taper-lok is

made up of a tapered pin with head at one end and threads on other. They are available with flush or protruding heads and as shear or tension types. Pins are divided into groups by grip length and head size. Diameter increases from group to group. Self aligning features are attained through use of a spherical base washernut. A washernut is a self-locking nut with a floating washer as an integral part. Taper-loks are structural fasteners used for high fatigue resistance and joint movement resistance. They are installed into drilled, reamed, and tapered interference fit hole.

a. Pin materials are; alloy steel, titanium, A286 stainless steel, and PH13-8MO stainless steel.

b. Taper-loks are installed in below listed material by type:

Type I Aluminum.

Type II Titanium.

Type III 15-5PH steel and 301 steel.





Type IV Alloy steel heat treated to 220-240,000 psi or less.

16. **SHEAR HEAD RIVET, 120° COUNTERSINK (FAST RIVET).** See figure 8. Fast rivets are made of aluminum and titanium.

17. Removal.

a. Using same size twist drill used to make hole, refer to table 7, lightly point center of rivet head. Examine point mark to make sure it is approximately in center of head. If point is not approximately centered, use twist drill to shift point mark in correct direction. Use 118° included angle twist drill with sharp points. A center punch may be used for pointing rivet center.

Table 7. Fast Rivet Requirements

NOM Rivet Dia.	Hole Dia.	Recommended Twist Drill Size	Countersink/ Counterbore 120° Cutter 	Counterbore Dia.	Counterbore NO-GO Gage 	Flushness Gage 
1/8	0.128-0.134	#30 (0.1285)	FSC-4	0.1625-0.1655	FSG-4	FSDG-4
5/32	0.161-0.166	#20 (0.161)	FSC-5	0.2105-0.2140	FSG-5	FSDG-5
3/16	0.192-0.198	#11 (0.191)	FSC-6	0.2585-0.2625	FSG-6	FSDG-6
1/4	0.255-0.262	6.5MM (0.2559)	FSC-8	0.3305-0.3360	FSG-8	FSDG-8
 All tools available from: Briles Rivet Corporation 2640 Vista Pacific Drive Oceanside, Calif. 92054						

b. Drill rivet head approximately through its height as shown in figure 8.

c. Using drift punch approximately 1/32 inch under twist drill size and held perpendicular to sheet surface, punch rivet shank out of hole, shearing it from rivet head. Support back side of structure during this step. In thick material it may be required to drill through rivet shank before driving it out. If this is required, use twist drill 1/32 inch under rivet diameter.

d. Use drift punch to pry remaining rivet head out of hole.

e. Inspect hole(s) for damage and for correct dimensions per table 7 before reinstalling same rivet size. Damaged holes will require use of next size rivet.

18. Installation.

a. Drill holes to size, refer to table 7.

b. Prepare counterbore/countersink using specific FSC cutter installed in FSA-20 micro stop cage, see figure 8. Cutter has an oversize thread and will only fit in the FSA-20 cage. The FSA-20 cage has an internal stop which prevents adjustments beyond maximum counterbore depth. Adjust, initially, by tightening skirt all the way in against stop shoulder, then backing off one or two notches.

Prepare counterbore/countersinks in a setup specimen and fine adjust cage as required for correct flushness requirements.

c. Test counterbore/countersink for correct depth by placing rivet in hole and test flushness from center of rivet head to surrounding sheet surface. Rivet should be flush within +0.001 to -0.003 inch. This test can also be made with an FSDG depth gage, refer to table 7.

d. Test to make sure counterbore diameter is not beyond maximum size using a FSG counterbore, no-go gage, refer to table 7. This gage should not go into counterbore. Rivet to be installed serves as go-gage.

e. Install rivets same as conventional rivets, by squeezing or bucking. Formed head dimensions are same as for conventional rivets.

f. Because of the head expansion feature of this rivet, it is required the rivet be firmly seated in hole before driving.

g. Wet installation, when required, shall only be made with wet primer. The head expansion feature prevents correct extrusion of excess wet sealant materials.

19. **BLIND RIVETS.** (NAVAIR 01-1A-8).

20. **BOLTS.** (NAVAIR 01-1A-8).

21. EDDIE-BOLTS.

Support Equipment Required

Part Number or Type Designation	Nomenclature
See Table 10E.	Tool List

Materials Required

None

21A. Description. Eddie-bolts are made of two parts, threaded pin and threaded collar. The collar has three lobes, which are deformed by wiping action of driving tool when collar contacts surface of structure. This action forces collar material into flutes located on pin threaded portion, providing mechanical lock. Wiping action of collar lobes also causes preloading (tightening) to predetermined torque. To prevent overtightening fasteners, driving tool will spin free over collar at correct torque. The threaded end of the pin contains a hexagon shaped recess which engages hex wrench to prevent rotation of pin while collar is being installed. There are two types of Eddie-Bolts. Type I Eddie-Bolts are only available in flush heads for shear applications. Type II Eddie-Bolts are available in both shear and tension head with 100 degree flush and protruding head styles. The pins have 1/16 inch grip variation. Type I pins, collars, and installation tools shall not be mixed with the type II pins, collars, and installation tools.

21B. Requirements.

- a. Eddie-Bolt type I and type II components and tooling may not be mixed.
- b. Washers may be used under collars to adjust grip lengths to meet thread protrusion limits.
- c. Maximum total washer thickness shall be 0.032 inch. Maximum number of washers shall be one, except if 0.016 thick washers are used, then two may be used.
- d. Only aluminum washers shall be used with aluminum collars.
- e. Only corrosion resistant steel washers shall be used with corrosion resistant steel collars.

f. Pins are lubricated by the manufacturer for proper installation. Do not degrease or lubricate before installation.

g. Collars shall not be reused under any circumstances. Pins may be reused provided they are not damaged and are free of cured sealant or other contaminants.

h. If installing pin wet with sealant, apply sealant to the head after partial installation. The sealant must be removed from the pin threads. If sealant is embedded into pin hex recess, the wrench will not engage properly.

i. A properly swaged collar is acceptable if the top of collar is flush with or protrudes above the sheet metal gage leaf when the gage is placed over the swaged collar.

j. A properly swaged collar is acceptable if the tube gage passes over the full length when the gage is placed over the swaged collar.

21C. Identification. See figure 9.

a. Type I. See tables 8 and 9.

(1) Pin EB1120N (3M1052V) titanium, flush shear head.

(2) Pin EB1140N (3M1052C) CRES, flush shear head.

(3) Collar EB73 (3M972) aluminum, shear, dyed green.

b. Type II. See tables 10 and 10A.

(1) Pin EL1201 (3M1246V) titanium, flush shear head.

(2) Pin EL1401 (3M1246C) CRES, flush shear head.

(3) Pin EL3201 (3M1245V) titanium, flush tension head.

(4) Pin EL3401 (3M1245C) CRES, flush tension head.

(5) Pin EL2201 (3M1247V) titanium, protruding shear head.

(6) Pin EL2401 (3M1247C) CRES, protruding shear head.

(7) Pin EL4201 (3M1248V) titanium, protruding tension head.

(8) Pin EL4401 (3M1248C) CRES, protruding tension head.

(9) Collar EN1101 (3M1249N) aluminum, shear, not painted.

(10) Collar EN1181 (3M1249V) titanium, shear, painted white.

(11) Collar EN1131 (3M1249C) CRES, shear, painted yellow.

(12) Collar EN1301 (3M1270N) aluminum, tension, not painted.

(13) Collar EN1381 (3M1270V) titanium, tension, painted white.

(14) Collar, EN1331 (3M1270C) CRES, tension, painted yellow.

22. Grip Length Selection.

a. Determine thickness of material being joined using a grip gage.

b. The fastener grip length dash number is the maximum material thickness, in sixteenths of an inch, that can be joined.

c. The fastener length selected shall install within the thread protrusion limits in table 10B or 10C.

23. Installation. See figure 10.



If sealant is embedded into pin hex recess, the wrench will not correctly engage, causing wrench breakage or hex recess stripping.

NOTE

If pins require wet sealant installation, avoid allowing sealant to cure before installing collar.

a. Insert pin into hole and inspect for correct head seating. If wet sealant installation is required,

apply wet sealant around head and shank of pin before it is seated. Avoid getting sealant on the threads. If head is not seated correctly, light tapping with plastic mallet is allowed or use phenolic block on pin head and strike block with plastic mallet.

b. Turn collar onto pin threads by hand at least 3/4 turn or until it contacts structure.

c. Insert hex wrench tip of driver tool into recess.

d. Firmly press driver tool against collar, operate driver tool until socket becomes free spinning.

e. Remove driver tool, installation is complete.

f. Inspect installed fastener using figure 12 and the following.

(1) Verify thread protrusion using table 10B or 10C.

(2) Verify fastener meets good/bad criteria of table 10D.

(3) Verify collar lobes have been swaged throughout the entire length using the correct gage.

g. Touch up installed fastener and surrounding area, as required (A1-F18AC-SRM-500, WP011 00 and WP012 00).

24. Removal. See figure 10.

a. Hold pin with a hex wrench.

b. Turn collar off pin using pliers.

Table 8. Eddie-Bolt, Type I Identification

FASTENER STYLE	MCDONNELL PART NUMBER	VENDOR PART NUMBER	MATERIAL	SIZE
FLUSH SHEAR HEAD	3M1052V3-()	EB1120N6A()	TITANIUM	3/16
	3M1052V4-()	EB1120N8A()	TITANIUM	1/4
	3M1052V3L()	EB1120N6E()	TITANIUM	3/16
	3M1052V4L()	EB1120N8E()	TITANIUM	1/4
	3M1052C3-()	EB1140N6B()	CRES	3/16
	3M1052C4-()	EB1140N8B()	CRES	1/4
	3M1054-3-()	EB1140N6B()X	CRES	3/16 FIRST O/S
	3M1054-4-()	EB1140N8B()X	CRES	1/4 FIRST O/S
	3M1053-3-()	EB1140N6B()Y	CRES	3/16 SECOND O/S
	3M1053-4-()	EB1140N8B()Y	CRES	1/4 SECOND O/S

Table 9. Eddie-Bolt, Type I Collar Identification

STYLE	MCDONNELL PART NUMBER	VENDOR PART NUMBER	MATERIAL	SIZE
SHEAR	3M972-3	EB73-6	ALUMINUM	3/16
	3M972-4	EB73-8	ALUMINUM	1/4

Table 10. Eddie-Bolt, Type II Identification











FASTENER STYLE	MCDONNELL PART NUMBER	VENDOR PART NUMBER	MATERIAL	SIZE
FLUSH SHEAR HEAD	3M1246V08-()A	EL1201NC5-()A	TITANIUM	5/32
	3M1246V3-()A	EL1201NC6-()A	TITANIUM	3/16
	3M1246V4-()A	EL1201NC8-()A	TITANIUM	1/4
	3M1246V5-()A	EL1201NC10-()A	TITANIUM	5/16
	3M1246V6-()A	EL1201NC12-()A	TITANIUM	3/8
	3M1246C08-()A	EL1401NC5-()A	CRES	5/32
	3M1246C3-()A	EL1401NC6-()A	CRES	3/16
	3M1246C4-()A	EL1401NC8-()A	CRES	1/4
	3M1246C5-()A	EL1401NC10-()A	CRES	5/16
	3M1246C6-()A	EL1401NC12-()A	CRES	3/8
	3M1246V08L()A	EL1201NF5-()A	 TITANIUM	5/32
	3M1246V3L()A	EL1201NF6-()A	 TITANIUM	3/16
	3M1246V4L()A	EL1201NF8-()A	 TITANIUM	1/4
	3M1246V5L()A	EL1201NF10-()A	 TITANIUM	5/16
	3M1246V6L()A	EL1201NF12-()A	 TITANIUM	3/8
	3M1246C08L()A	EL1401NF5-()A	 CRES	5/32
	3M1246C3L()A	EL1401NF6-()A	 CRES	3/16
	3M1246C4L()A	EL1401NF8-()A	 CRES	1/4
	3M1246C5L()A	EL1401NF10-()A	 CRES	5/16
	3M1246C6L()A	EL1401NF12-()A	 CRES	3/8

Table 10. Eddie-Bolt, Type II Identification (Continued)





















FASTENER STYLE	MCDONNELL PART NUMBER	VENDOR PART NUMBER	MATERIAL	SIZE
FLUSH TENSION HEAD	3M1245V08-()A	EL3201NC5-()A	TITANIUM	5/32
	3M1245V3-()A	EL3201NC6-()A	TITANIUM	3/16
	3M1245V4-()A	EL3201NC8-()A	TITANIUM	1/4
	3M1245V5-()A	EL3201NC10-()A	TITANIUM	5/16
	3M1245V6-()A	EL3201NC12-()A	TITANIUM	3/8
	3M1245C08-()A	EL3401NC5-()A	CRES	5/32
	3M1245C3-()A	EL3401NC6-()A	CRES	3/16
	3M1245C4-()A	EL3401NC8-()A	CRES	1/4
	3M1245C5-()A	EL3401NC10-()A	CRES	5/16
	3M1245C6-()A	EL3401NC12-()A	CRES	3/8
	3M1245V08L()A	EL3201NF5-()A	 1 TITANIUM	5/32
	3M1245V3L()A	EL3201NF6-()A	 1 TITANIUM	3/16
	3M1245V4L()A	EL3201NF8-()A	 1 TITANIUM	1/4
	3M1245V5L()A	EL3201NF10-()A	 1 TITANIUM	5/16
	3M1245V6L()A	EL3201NF12-()A	 1 TITANIUM	3/8
	3M1245C08L()A	EL3401NF5-()A	 1 CRES	5/32
	3M1245C3L()A	EL3401NF6-()A	 1 CRES	3/16
	3M1245C4()A	EL3401NF8-()A	 1 CRES	1/4
	3M1245C5L()A	EL3401NF10-()A	 1 CRES	5/16
	3M1245C6L()A	EL3401NF12-()A	 1 CRES	3/8
PROTRUDING SHEAR HEAD	3M1247V08-()	EL2201NC5-()	TITANIUM	5/32
	3M1247V3-()	EL2201NC6-()	TITANIUM	3/16
	3M1247V4-()	EL2201NC8-()	TITANIUM	1/4
	3M1247V5-()	EL2201NC10-()	TITANIUM	5/16
	3M1247V6-()	EL2201NC12-()	TITANIUM	3/8
	3M1247C08-()	EL2401NC5-()	CRES	5/32
	3M1247C3-()	EL2401NC6-()	CRES	3/16
	3M1247C4-()	EL2401NC8-()	CRES	1/4
	3M1247C5-()	EL2401NC10-()	CRES	5/16
	3M1247C6-()	EL2401NC12-()	CRES	3/8
	3M1247V08L()	EL2201NF5-()	 1 TITANIUM	5/32
	3M1247V3L()	EL2201NF6-()	 1 TITANIUM	3/16
	3M1247V4L()	EL2201NF8-()	 1 TITANIUM	1/4
	3M1247V5L()	EL2201NF10-()	 1 TITANIUM	5/16
	3M1247V6L()	EL2201NF12-()	 1 TITANIUM	3/8
	3M1247C08L()	EL2401NF5-()	 1 CRES	5/32
	3M1247C3L()	EL2401NF6-()	 1 CRES	3/16
	3M1247C4L()	EL2401NF8-()	 1 CRES	1/4
	3M1247C5L()	EL2401NF10-()	 1 CRES	5/16
	3M1247C6L()	EL2401NF12-()	 1 CRES	3/8

Table 10. Eddie-Bolt, Type II Identification (Continued)












FASTENER STYLE	MCDONNELL PART NUMBER	VENDOR PART NUMBER	MATERIAL	SIZE
PROTRUDING TENSION HEAD	3M1248V08-()	EL4201NC5-()	TITANIUM	5/32
	3M1248V3-()	EL4201NC6-()	TITANIUM	3/16
	3M1248V4-()	EL4201NC8-()	TITANIUM	1/4
	3M1248V5-()	EL4201NC10-()	TITANIUM	5/16
	3M1248V6-()	EL4201NC12-()	TITANIUM	3/8
	3M1248C08-()	EL4401NC5-()	CRES	5/32
	3M1248C3-()	EL4401NC6-()	CRES	3/16
	3M1248C4-()	EL4401NC8-()	CRES	1/4
	3M1248C5-()	EL4401NC10-()	CRES	5/16
	3M1248C6-()	EL4401NC12-()	CRES	3/8
	3M1248V08L()	EL4201NF5-()	 TITANIUM	5/32
	3M1248V3L()	EL4201NF6-()	 TITANIUM	3/16
	3M1248V4L()	EL4201NF8-()	 TITANIUM	1/4
	3M1248V5L()	EL4201NF10-()	 TITANIUM	5/16
	3M1248V6L()	EL4201NF12-()	 TITANIUM	3/8
	3M1248C08L()	EL4401NF5-()	 CRES	5/32
	3M1248C3L()	EL4401NF6-()	 CRES	3/16
	3M1248C4L()	EL4401NF8-()	 CRES	1/4
	3M1248C5L()	EL4401NF10-()	 CRES	5/16
	3M1248C6L()	EL4401NF12-()	 CRES	3/8
NOTES				
 Dry film lubricant applied..				

Table 10A. Eddie - Bolt, Type II Collar Identification

STYLE	MCDONNELL PART NUMBER	VENDOR PART NUMBER	MATERIAL	SIZE
SHEAR	3M1249N08	EN1101CR5	ALUMINUM	5/32
	3M1249N3	EN1101CR6	ALUMINUM	3/16
	3M1249N4	EN1101CR8	ALUMINUM	1/4
	3M1249N5	EN1101CR10	ALUMINUM	5/16
	3M1249N6	EN1101CR12	ALUMINUM	3/8
	3M1249V08	EN1181ND5	TITANIUM	5/32
	3M1249V3	EN1181ND6	TITANIUM	3/16
	3M1249V4	EN1181ND8	TITANIUM	1/4
	3M1249V5	EN1181ND10	TITANIUM	5/16
	3M1249V6	EN1181ND12	TITANIUM	3/8
	3M1249C08	EN1131ND5	CRES	5/32
	3M1249C3	EN1131ND6	CRES	3/16
	3M1249C4	EN1131ND8	CRES	1/4
	3M1249C5	EN1131ND10	CRES	5/16
	3M1249C6	EN1131ND12	CRES	3/8
	3M1270N08	EN1301CR5	ALUMINUM	5/32
	3M1270N3	EN1301CR6	ALUMINUM	3/16
	3M1270N4	EN1301CR8	ALUMINUM	1/4
	3M1270N5	EN1301CR10	ALUMINUM	5/16
	3M1270N6	EN1301CR12	ALUMINUM	3/8
	3M1270V08	EN1381ND5	TITANIUM	5/32
	3M1270V3	EN1381ND6	TITANIUM	3/16
	3M1270V4	EN1381ND8	TITANIUM	1/4
	3M1270V5	EN1381ND10	TITANIUM	5/16
	3M1270V6	EN1381ND12	TITANIUM	3/8
	3M1270C08	EN1331ND5	CRES	5/32
	3M1270C3	EN1331ND6	CRES	3/16
	3M1270C4	EN1331ND8	CRES	1/4
	3M1270C5	EN1331ND10	CRES	5/16
	3M1270C6	EN1331ND12	CRES	3/8

Table 10B. Eddie-Bolt, Type I Thread Protrusion Limits

Nominal Fastener Diameter	McDonnell Dia Dash Number	Standard and First Oversize		Second Oversize	
		"P" Minimum Protrusion 2	"P" Maximum Protrusion 2	"P" Minimum Protrusion	"P" Maximum Protrusion
3/16	-3	0.315	0.397	0.350	0.432
1/4	-4	0.385	0.467	0.425	0.507

NOTES

1. When washers are used under collar, protrusion measurements shall be made from washer surface.

2 Use 2-1522 thread protrusion gage .

Table 10C. Eddie-Bolt, Type II Thread Protrusion Limits

Nominal Fastener Diameter	McDonnell Dia Dash Number	"P" Minimum Protrusion 2	"P" Maximum Protrusion 2
5/32	-08	0.275	0.358
3/16	-3	0.295	0.378
1/4	-4	0.340	0.423
5/16	-5	0.435	0.518
3/8	-6	0.475	0.558

NOTES

1. When washers are used under collar, protrusion measurements shall be made from washer surface.

2 Use EB2G1309 thread protrusion gage .

Table 10D. Good/Bad Limits

Condition	Good/Bad Limits
1. Gaps between sheets.	BAD: If gap extends to shank.
2. Gaps under collars seated against sheet metal parts or against non-metallic parts.	BAD: If gap extends to shank.
3. Gaps under collars seated against concave or convex surfaces of formed flanges or parts machined to radii less than 6.0 inch.	GOOD: If both of following conditions are met: (a) Collar must be seated on two diametrically opposite sides. (b) Gaps to shank shall be less than 0.005 inch.
4. Gaps under collars for conditions not defined in conditions 2 and 3.	BAD: If gap extends to shank.
5. Gaps under fastener head.	BAD: If 0.005 inch feeler gage can be inserted to shank. Gaps permitting insertion of 0.004 inch feeler gage are good provided no more than 40 percent of circumference has gap.
6. Collar lobes not swaged over entire length.	BAD: Collar may be reswaged.

Table 10D. Good/Bad Limits (Continued)

Condition	Good/Bad Limits
7. Collar swage gage will not slide over lobed part of collar.	BAD: Indicates tool is worn. Do not attempt to reswage collars having this condition. Remove and replace.
8. Loose fastener; can be moved axially or rotated with fingers.	BAD: Replace.
9. Wrench or plier type marks on collars.	BAD: Any collar showing evidence of being re-tightened after installation.

Table 10E. Eddie-Bolt Tools

TYPE	TOOL	PART NUMBER	DESCRIPTION
TYPE I	INSTALLATION TOOLS	EBT 4001-6 EBT 4001-8 EBT 5010-6 EBT 5010-8 EBT 7002-6 EBT 7002-8 EBT 7102-6 EBT 7102-8	SOCKET WRENCH SOCKET WRENCH RATCHET WRENCH RATCHET WRENCH HAND WRENCH HAND WRENCH HAND WRENCH HAND WRENCH
	GAGE	EBG 1002 SERIES EBG 1101 SERIES 2-1522	TUBE GAGE SHEET METAL GAGE PIN PROTRUSION
TYPE II	INSTALLATION TOOLS	RWB100-80 EB2T4020-5 EB2T4020-6 EB2T4020-8 EB2T5000-5 EB2T5000-6 EB2T5000-8 EB2T5200-6 EB2T5200-8 EB2T7000-5 EB2T7000-6 EB2T7000-8 EB2T7100-6 EB2T7100-8 EB2T7200-6 EB2T7200-8	ROLLER WRENCH SQUARE DR SOCKET SQUARE DR SOCKET SQUARE DR SOCKET RATCHET WRENCH RATCHET WRENCH RATCHET WRENCH 15 OFFSET DRIVER 15 OFFSET DRIVER CURVED DRIVER CURVED DRIVER CURVED DRIVER 45 OFFSET DRIVER 45 OFFSET DRIVER STRAIGHT DRIVER STRAIGHT DRIVER
	GAGE	EB2G1000 SERIES EB2G1100 SERIES EB2G1309	TUBE GAGE SHEET METAL GAGE PIN PROTRUSION

25. **JO-BOLTS / VISU-LOK II.** (NAVAIR 01-1A-8).
See table 11 and figures 13 and 14.

Table 11. Cross Reference Chart

VISU-LOK II P/N	NAS P/N	Replacement for			
		VISU-LOK	OLD NAS P/N	Obsolete	
				JO-BOLT	NAS P/N
<div>1</div> PLT5110-5-() -6-() -8-() -10-() -12-()	1670-08DL() -03DL() -04DL() -05DL() -06DL()	PLT110-5-() -6-() -8-() -10-() -12-()	1670-08L() -03L() -04L() -05L() -06L()	FF164-() 200-() 260-() 312-() 375-()	1670-08 () -03 () -04 () -05 () -06 ()
<div>2</div> PLT5111-5-() -6-() -8-() -10-() -12-()	1750-08DL() -03DL() -04DL() -05DL() -06DL()	PLT111-5-() -6-() -8-() -10-() -12-()	1750-08L() -03L() -04L() -05L() -06L()	FF0164() 200-() 260-() 312-() 375-()	None

Table 11. Cross Reference Chart (Continued)

VISU-LOK II P/N	NAS P/N	Replacement for			
		VISU-LOK	OLD NAS P/N	Obsolete	
				JO-BOLT	NAS P/N
<div>3</div> PLT5114-5-() -6-() -8-() -10-() -12-()	None	PLT114-5-() -6-() -8-() -10-() -12-()	None	FF164-() 200-() 260-() 312-() 375-()	None
<div>4</div> PLT5115-5-() -6-() -8-() -10-() -12-()	None	PLT115-5-() -6-() -8-() -10-() -12-()	None	FF164-() 190-() 250-() 312-() 375-()	None
<div>5</div> PLT5120-5-() -6-() -8-() -10-() -12-()	1672-08DL() -03DL() -04DL() -05DL() -06DL()	PLT120-5-() -6-() -8-() -10-() -12-()	1672-08L() -03L() -04L() -05L() -06L()	FF164ALS-() 200ALS-() 260ALS-() 312ALS-() 375ALS-()	1672-08 () -03 () -04 () -05 () -06 ()
<div>6</div> PLT5121-5-() -6-() -8-() -10-() -12-()	1752-08DL() -03DL() -04DL() -05DL() -06DL()	PLT121-5-() -6-() -8-() -10-() -12-()	1752-08L() -03L() -04L() -05L() -06L()	FO164ALS-() 200ALS-() 260ALS-() 312ALS-() 375ALS-()	None
<div>7</div> PLT5130-5-() -6-() -8-()	1674-08DL() -03DL() -04DL() -05DL() -06DL()	PLT130-5-() -6-() -8-()	1674-08L() -03L() -04L()	SSHFA164-() 200-() 260-()	1674-08() -03() -04()
<div>8</div> PLT5131-5-() -6-() -8-()	1754-08DL() -03DL() -04DL() -05DL() -06DL()	PLT131-5-() -6-() -8-()	1754-08L() -03L() -04L()	SSHFAO164-() 200-() 260-()	None

Table 11. Cross Reference Chart (Continued)

VISU-LOK II P/N	NAS P/N	Replacement for			
		VISU-LOK	OLD NAS P/N	Obsolete	
				JO-BOLT	NAS P/N
9 PLT5210-5-() -6-() -8-() -10-() -12-()	1669-08DL() -03DL() -04DL() -05DL() -06DL()	PLT210-5-() -6-() -8-() -10-() -12-()	1669-08L() -03L() -04L() -05L() -06L()	PP164-() 200-() 260-() 312-() 375-()	1669-08 () -03 () -04 () -05 () -06 ()
10 PLT5211-5-() -6-() -8-() -10-() -12-()	1751-08DL() -03DL() -04DL() -05DL() -06DL()	PLT211-5-() -6-() -8-() -10-() -12-()	1751-08L() -03L() -04L() -05L() -06L()	PPO164-() 200-() 260-() 312-() 375-()	None
11 PLT5214-5-() -6-() -8-() -10-() -12-()	None	PLT214-5-() -6-() -8-() -10-() -12-()	None	PPG164-() 200-() 260-() 312-() 375-()	None
12 PLT5215-5-() -6-() -8-() -10-() -12-()	None	PLT215-5-() -6-() -8-() -10-() -12-()	None	PP164-() 190-() 250-() 312-() 375-()	None
13 PLT5220-5-() -6-() -8-() -10-() -12-()	1671-08DL() -03DL() -04DL() -05DL() -06DL()	PLT220-5-() -6-() -8-() -10-() -12-()	1671-08L() -03L() -04L() -05L() -06L()	P164A-() 200A-() 260A-() 312A-() 375A-()	1671-08 () -03 () -04 () -05 () -06 ()
14 PLT5221-5-() -6-() -8-() -10-() -12-()	1753-08DL() -03DL() -04DL() -05DL() -06DL()	PLT221-5-() -6-() -8-() -10-() -12-()	1753-08L() -03L() -04L() -05L() -06L()	PO164A-() 200A-() 260A-() 312A-() 375A-()	None
15 PLT5230-5-() -6-() -8-()	1673-08DL() -03DL() -04DL()	PLT230-5-() -6-() -8-()	1673-08L() -03L() -04L()	PPA164-() 200-() 260-()	None

Table 11. Cross Reference Chart (Continued)

VISU-LOK II P/N	NAS P/N	Replacement for			
		VISU-LOK	OLD NAS P/N	Obsolete	
				JO-BOLT	NAS P/N
<div>16</div> PLT5231-5-() -6-() -8-()	1755-08DL() -03DL() -04DL()	PLT231-5-() -6-() -8-()	1755-08L() -03L() -04L()	PPAO164-() 200-() 260-()	None
<div>17</div> PLT5470-()-()	None	PLT1058-()-()	None	None	None

NOTES

- 1

 Alloy steel, flush head.
- 2

 Alloy steel, flush head, oversize.
- 3

 Alloy steel, flush head, ground shank.
- 4

 Alloy steel, flush head, fractional size.
- 5

 A-286, flush head.
- 6

 A-286, flush head, oversize.
- 7

 Aluminum, flush head.
- 8

 Aluminum, flush head, oversize.
- 9

 Alloy steel, protruding head.
- 10

 Alloy steel, protruding head, oversize.
- 11

 Alloy steel, protruding head, ground shank .
- 12

 Alloy steel, protruding head, fractional size.
- 13

 A-286, protruding head.
- 14

 A-286, protruding head, oversize.
- 15

 Aluminum, protruding head.
- 16










 Aluminum, protruding head, oversize.
- 17

 Titanium, flush shear head.


Table 12. Tooling


Dash No.	Head Style	VISU-LOK		VISU-LOK II	
		Wrench Adapter (Turns Screw)	Nose Adapter (Hold Nut)	Wrench Adapter (Turn Screw)	Nose Adapter (Hold Nut)
5	100° Flush 100° Shear Hex Millable	MP-5	MPF-5 MPR-5 MPP-5 MPA-5	MP-5	MPP-8 <div>4</div>
6	100° Flush 100° Shear Hex millable	MP-6	MPF-6 MPR-6 MPP-6 MPA-6	MP-6	


Table 12. Tooling (Continued)


Dash No.	Head Style	VISU-LOK		VISU-LOK II	
		Wrench Adapter (Turns Screw)	Nose Adapter (Hold Nut)	Wrench Adapter (Turn Screw)	Nose Adapter (Hold Nut)
8	100° Flush 100° Shear Hex Millable	MP-8	MPF-8 MPR-8 MPP-8  MPA-8	MP-8	
10	100° Flush 100° Shear Hex	MP-10 	MPF-10 MPR-10 MPP-10	MPTBF-10 	MPP-12  
12	100° Flush 100° Shear Hex	MP-12 	MPF-12 MPR-12  MPP-12 	MPTBF-12 	

NOTES

 1 Combination wrench adapter and torque driver, requires removal of master torque driver (MTD550) supplied with tool.

 2 Combination wrench adapter and torque driver, requires removal of master torque driver (MTD550BF) supplied with tool.

 3 Larger Male thread on nose adapters require removal of aluminum nut (MN550) supplied with tool.

 4 MPF-8 and MPP-12 are typically found in installation tool kits purchased through GSA for VISU-LOK installation and are applicable to VISU-LOK II.

26. **MILSON PANEL FASTENERS.**
(NAVAIR 01-1A-8).

27. **SELF-LOCKING SETSCREWS.** NAS1081 setscrews are used with HLT265TB8-()-()Hi-Lok fasteners. See figures 1 and 2, and refer to (NAVAIR 01-1A-8).

28. **SEALANT INJECTION FASTENERS.** These fasteners are used in channel seal groove at injection point locations. NAS1081 setscrews plug sealant injection hole. Refer to table 1 for Hi-Lok fasteners, and figure 1 for Hi-Lok identification.

29. **TERMINAL GROUND STUD ASSEMBLY MIL-T-83454.** Terminal ground stud assembly (ground stud), see figure 15, is made of two pieces, headed and threaded stud, and ductile, electrically conductive outer sleeve. Sleeve shoulder, or head, serves as positioning stop, standoff, and electrical contact surface. Threads and pulling stem protrude from sleeve shoulder. Ground stud is installed from one side of work. Installation is completed with

conventional pulling tools. On installation, ground stud is inserted into drilled hole and axial load is applied to stem and reacted against washer face of sleeve. Sleeve is displaced radially by expander boss, inducing interference fit and electrical contact in structure. Section of outer sleeve, which protrudes from backside of skin or structure before driving, is expanded outwardly into bulb. This bulb clamps skin or structure which bears tension loading of installed stud. Pull-stem is configured to separate at predetermined axial load required to install fastener correctly for best mechanical and electrical capabilities.

Support Equipment Required

Part Number or Type Designation

Nomenclature

RV30GB

Olympic Pneumatic-
Hydraulic Blind
Rivet Gun

Support Equipment Required (Continued)

Part Number or Type Designation	Nomenclature
RV911-10	Olympic Straight Pulling Head
RV981-10	Olympic Double Offset Pulling Head
—	Drill Motor, Pneumatic
—	Twist Drill, 5/16 or 0.3125 - 0.3165

Materials Required

NOTE

Alternate item part numbers are shown indented.

Specification or Part Number	Nomenclature
DS-108F	Solvent, Wipe
5772 048	Cleaning Compound
AA1048TY1CL1GRIT-240X9X11	Abrasive Cloth, Aluminum Oxide
CCC-C-46, TYPE 1, CLASS 4	Cleaning Cloth, Non woven Fabric

30. Removal.

a. Hit stud with several sharp blows, this will punch stud out, leaving sleeve shoulder assembly.

b. Drill out sleeve shoulder assembly, using twist drill slightly smaller than stud shank. Remaining material should be carefully picked out of hole.

31. Installation.

a. Remove finish in installation area (A1-F18AC-SRM-500, WP012 00).

b. Drill 0.3125 to 0.3165, 5/16 inch diameter hole.

WARNING

Solvent should be used with care. Gloves must be worn to prevent injury.

Cleaning compound may cause skin irritation. Avoid contact with skin and clothing. Wash thoroughly after handling.

c. Remove contamination from installation area using cleaning cloth moistened with solvent or cleaning compound. Allow to air dry 15 minutes.

d. Install bar stud immediately after cleaning installation area, using equipment listed in this work package.

e. Restore finish system in installation area per specific structure repair manual.

32. **GROUNDING RECEPTACLE, ST5M1441.** The ST5M1441 grounding receptacle is one piece cadmium plated, brass assembly used in grounding aircraft to ground, flight deck, or hangar deck. This assembly is attached to aircraft using washers and nuts shown in figure 16.

33. **HIGH-TORQUE AND TORQ-SET BOLTS.** (NAVAIR 01-1A-8).

34. **THREADED INSERTS.** (NAVAIR 01-1A-8).

35. **SOLID RIVETS.** (NAVAIR 01-1A-8).

36. **CLIP NUTS.**

a. Clip nuts, see figure 17, are used in combination with slotted holes where large amount of nut float is required to prevent deforming joined members during assembly. Load is transferred in direction of slot and some fretting occurs with joint movement.

b. This nut is used on hydraulic or wire bundle brackets, clamps.

37. **TORQUE REQUIREMENTS FOR FLUSH SCREWS IN REMOVABLE DOORS AND PANELS.** Controlled torque installation of flush screws in all removable doors and panels shall meet requirements listed. When specific torque values are listed in A1-F18AC-LMM-010 or A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750 they shall take precedence over those listed here.

38. Requirements.



To prevent damage to structure or skin, impact type power screw drivers shall not be used.

a. Power screw drivers which can be set to drive screws within torque limits of table 13 may be used.

b. Screws shall not be started into nut with power drivers.

c. There shall be no interference between screws and surrounding material and screws shall start freely into nut.

d. Screws shall be driven by method which will allow control of torque within limits of table 13.

e. Screw shall not be installed at higher torque than allowed by table 13, to bring it within flushness requirements.

39. Testing For Correct Torque Of Installed Screw.

a. Screw shall be tested with hand torque wrench; tightening screw little as possible.

b. Torque required to start screw turning shall be within limits of table 13.

Table 13. Screw Torque Values

Screw Size	Torque (Inch-Pounds)
10 - 32	25 + 00 -10
1/4 - 28	50 + -10
5/16 - 24	80 + -15
3/8 - 24	105 + -20
7/16 - 20	150 + -25
1/2 - 20	230 + -40
9/16 - 18	300 + -50
5/8 - 18	425 + -50

40. **BLIND BOLTS.** (NAVAIR 01-1A-8). When blind bolts are used, do not use in FOD areas.

41. **QUICK-RELEASE PIN RECEPTACLE.** See figure 16. Quick-release pin receptacles are installed in numerous places on aircraft to aid removal and installation of quick release pins used on ground protective devices (A1-F18AC-PCM-000).

a. Used with quick release pins only.

b. May be specified for specific skin thicknesses of 0.030 through 0.480 inch in 0.030 inch increments.

c. Remove or install (A1-F18AC-SRM-200, WP004 05) Plate Nuts.

42. **SPACER - PLATE NUT.** See figure 19. Made from 6061-T6 aluminum alloy with MS21209F1-15 corrosion resistant steel helical insert installed wet with zinc chromate primer.

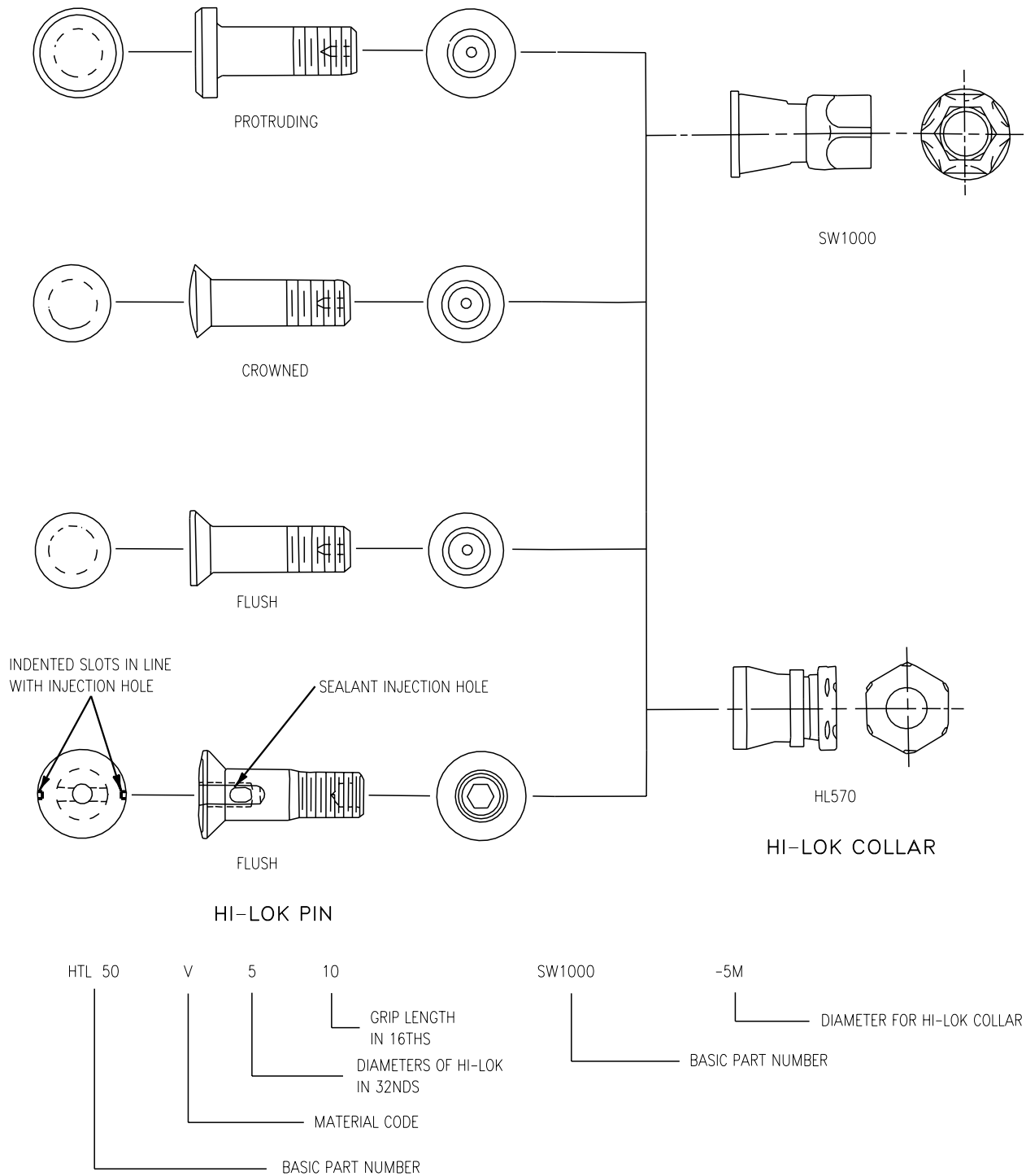


Figure 1. Hi-Lok Pin and Collar Identification (Sheet 1)

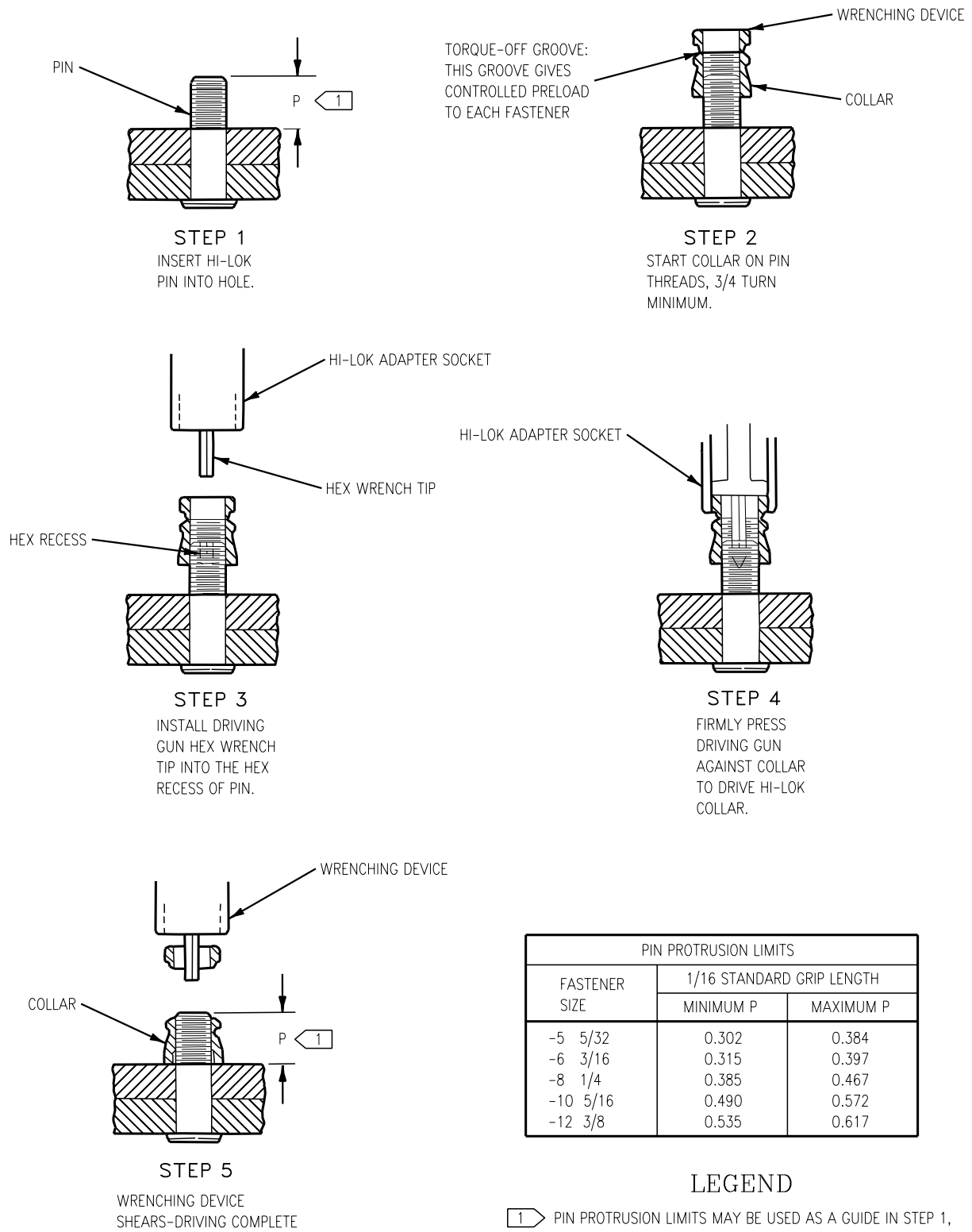
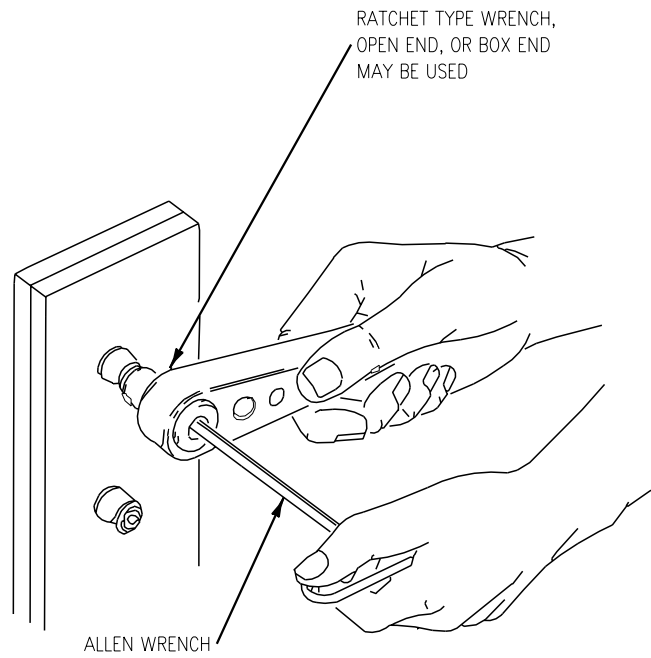
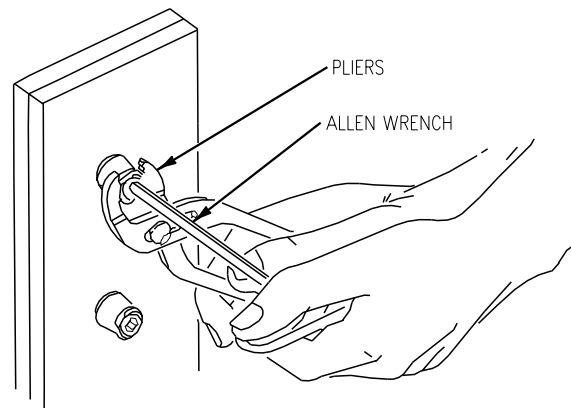


Figure 2. Hi-Lok Removal and Installation (Sheet 1)

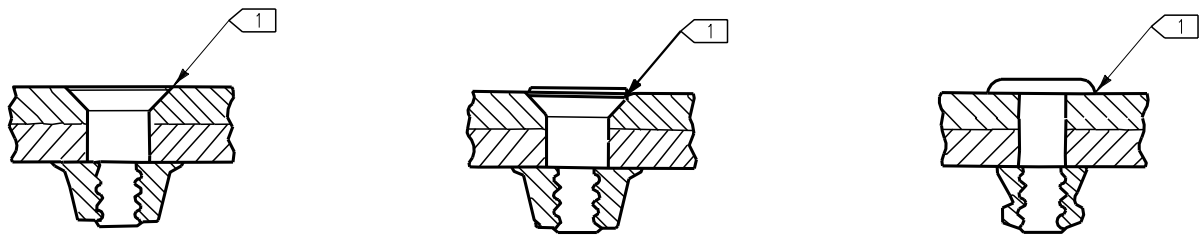


HAND TOOL INSTALLATION
ALTERNATE METHOD

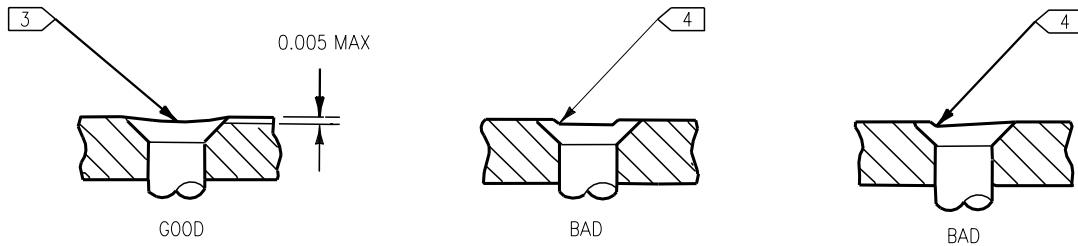


HAND TOOL REMOVAL

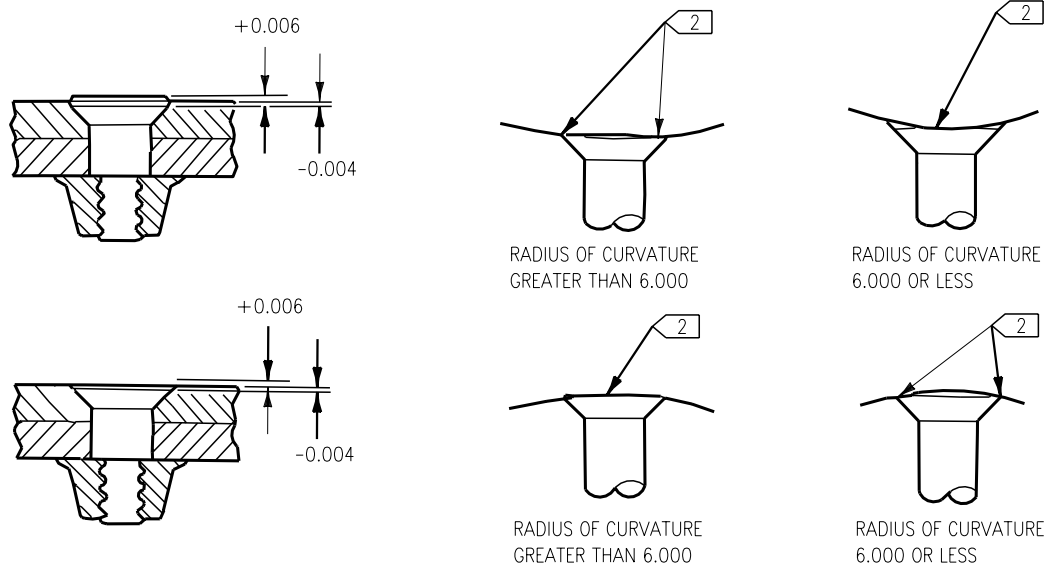
Figure 2. Hi-Lok Removal and Installation (Sheet 2)



HEAD GAP LIMITS



HEAD DAMAGE OR FLUSH GAP INSPECTION




FLUSH HEAD TO SURFACE REQUIREMENTS

LEGEND

- 1 REPLACE FASTENER IF 0.005 FEELER GAGE CAN BE INSERTED TO SHANK. GAPS OF 0.004 AT 40 PERCENT OF HEAD CIRCUMFERENCE ARE GOOD.
- 2 MEASURE FLUSHNESS AT POINTS INDICATED.
- 3 HEAD DISHING THAT IS SMOOTH AND UNIFORM IS GOOD PROVIDED IT DOES NOT EXCEED 0.005 INCH DEPTH.
- 4 HEAD DISHING THAT SHOWS A DISTINCT RING CAUSED BY AN ABRUPT STEP IN THE HEAD IS NOT ALLOWED.

Figure 3. Hi-Lok Inspection


ST3M512-5-5
 └── GRIP LENGTH
 └── DIAMETER 
 └── BASIC PART NUMBER

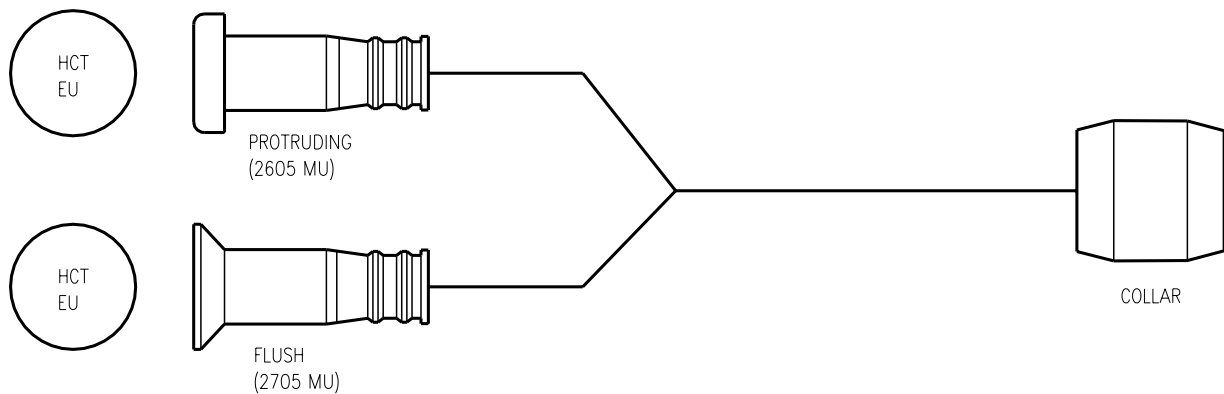
2605MU-5
 └── GRIP LENGTH
 └── LAST TWO NUMBERS DENOTE DIAMETER
 └── BASIC PART NUMBER

ST3M428C4-4
 └── GRIP LENGTH
 └── DIAMETER
 └── MATERIAL
 └── BASIC PART NUMBER

SLSPCTEU-4-4
 └── GRIP LENGTH
 └── DIAMETER
 └── BASIC PART NUMBER

LEGEND

 MCAIR P/N IN 1/16 DIA.
 VENDOR P/N IN 1/32 DIA.



ST3M509-5-5
 └── GRIP LENGTH
 └── DIAMETER
 └── BASIC PART NUMBER

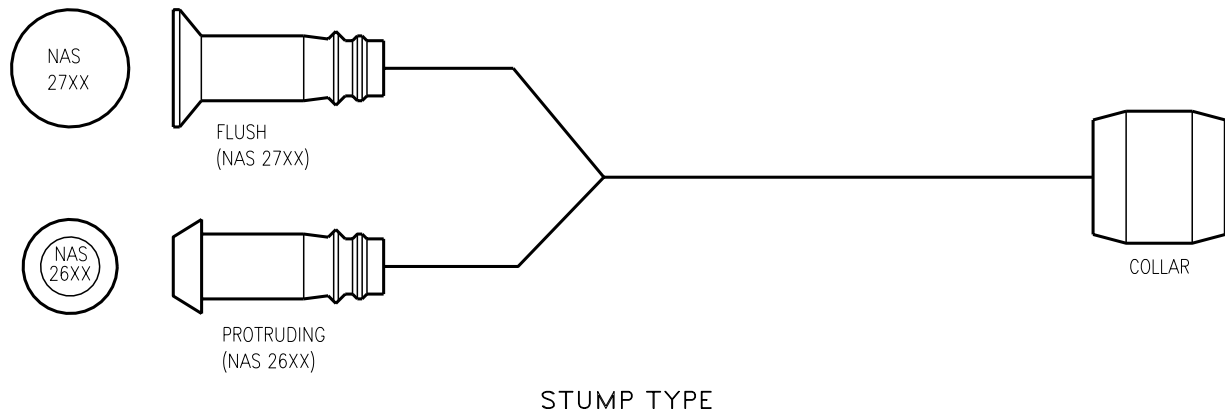
2705MU-5
 └── GRIP LENGTH
 └── LAST TWO NUMBERS DENOTE DIAMETER
 └── BASIC PART NUMBER

ST3M427C4-4
 └── GRIP LENGTH
 └── DIAMETER
 └── MATERIAL
 └── BASIC PART NUMBER

SLS100CREU-4-4
 └── GRIP LENGTH
 └── DIAMETER
 └── BASIC PART NUMBER

CORROSION RESISTANT STEEL LOCKBOLTS

Figure 4. Lockbolt Identification (Sheet 1)

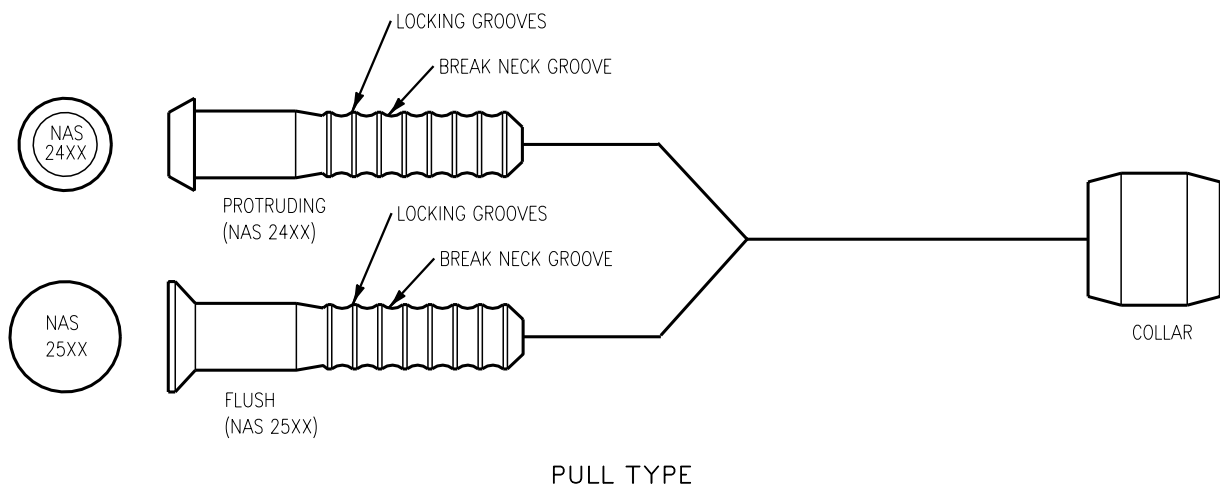


NAS2705V-5

- GRIP LENGTH
- LAST TWO NUMBERS DENOTE DIAMETER
- BASIC PART NUMBER

2DC-EU5T

- DIAMETER
- BASIC PART NUMBER



NAS2404 V 6

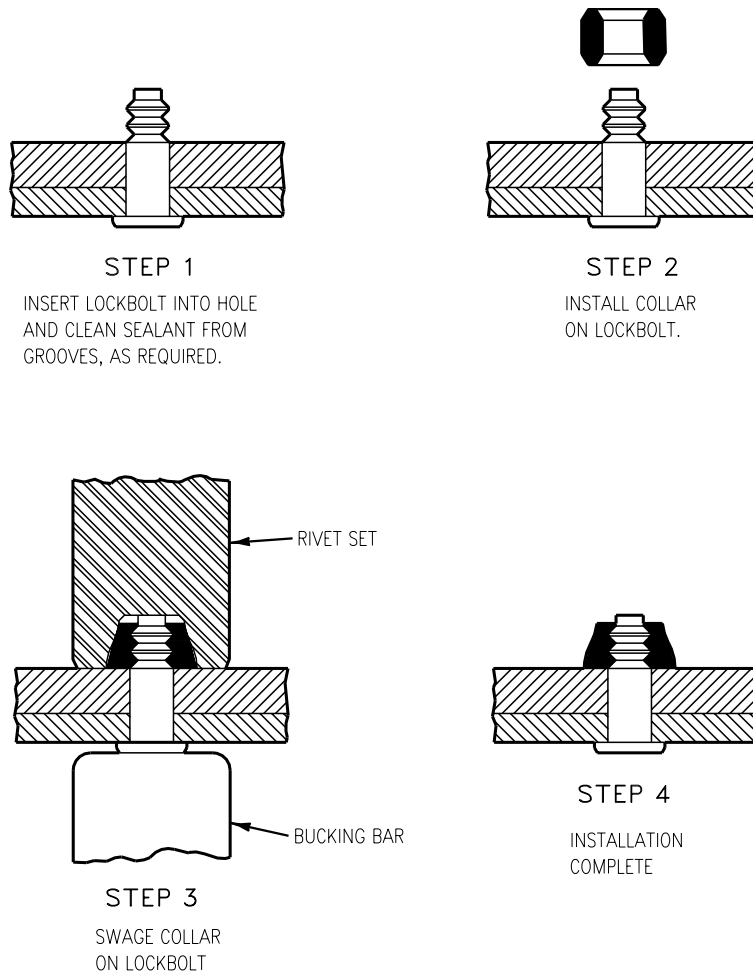
- GRIP LENGTH
- MATERIAL CODE
- LAST TWO NUMBERS OF BASIC PART NUMBER DENOTE DIAMETER
- BASIC PART NUMBER

2DC-2AC 6

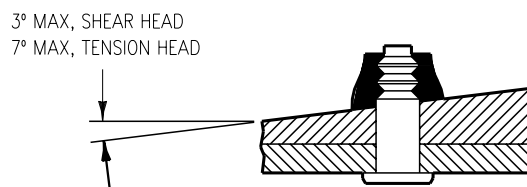
- DIAMETER
- BASIC PART NUMBER

TITANIUM LOCKBOLTS

Figure 4. Lockbolt Identification (Sheet 2)

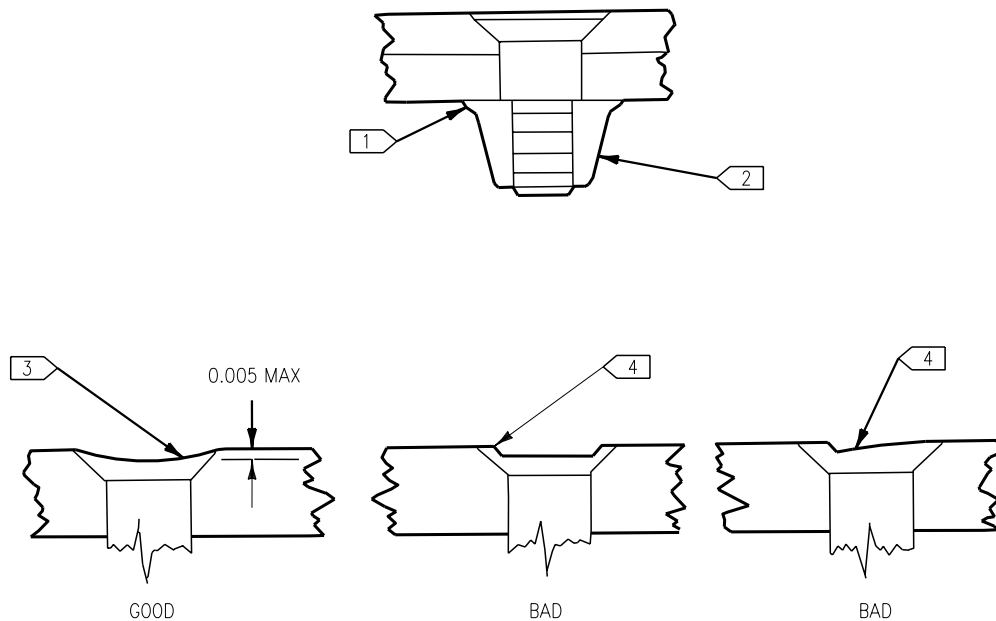


INSTALLATION OF LOCKBOLTS



INSTALLING LOCKBOLT COLLAR ON SLOPING SURFACE

Figure 5. Lockbolt Identification



HEAD DAMAGE INSPECTION

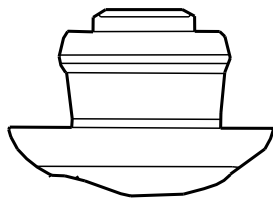
LEGEND

- 1 SWAGING OF COLLARS MAY PRODUCE A PAD OF EXCESS MATERIAL AT BOTTOM OF COLLAR ON SLOPED SURFACES. PAD WILL EXIST ON ONE SIDE ONLY AND THIS CONDITION IS GOOD.
- 2 LOCALIZED ABSENCE OF IDENTIFICATION DYES ON SWAGED COLLARS IS GOOD.
- 3 HEAD DISHING THAT IS SMOOTH AND UNIFORM IS GOOD PROVIDED IT DOES NOT EXCEED 0.005 DEPTH.
- 4 HEAD DISHING THAT SHOWS A DISTINCT RING CAUSED BY AN ABRUPT STEP IN HEAD IS BAD.

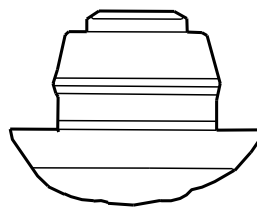
Figure 6. Lockbolt Inspection (Sheet 1)

GAGES FOR SHEAR OR TENSION PULL TYPE FASTENERS ARE PIN POSITIONS GAGES ONLY. SWAGED COLLARS ARE VISUALLY INSPECTED AS BELOW.

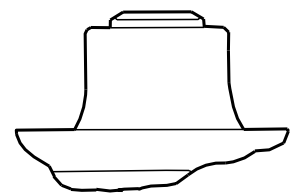
BEADED COLLARS



NOT SWAGED
BAD

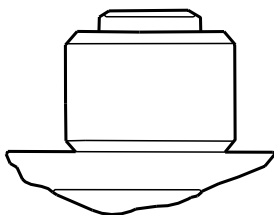


PARTIALLY SWAGED
BAD

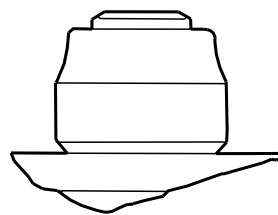


FULLY SWAGED
GOOD

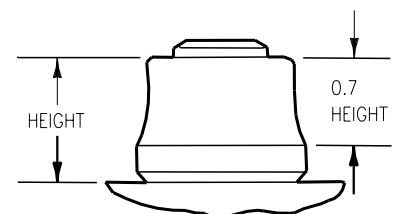
DOUBLE END COLLARS



NOT SWAGED
BAD

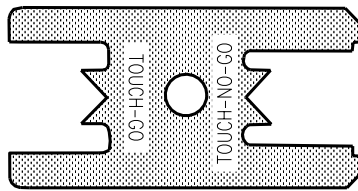


PARTIALLY SWAGED
BAD

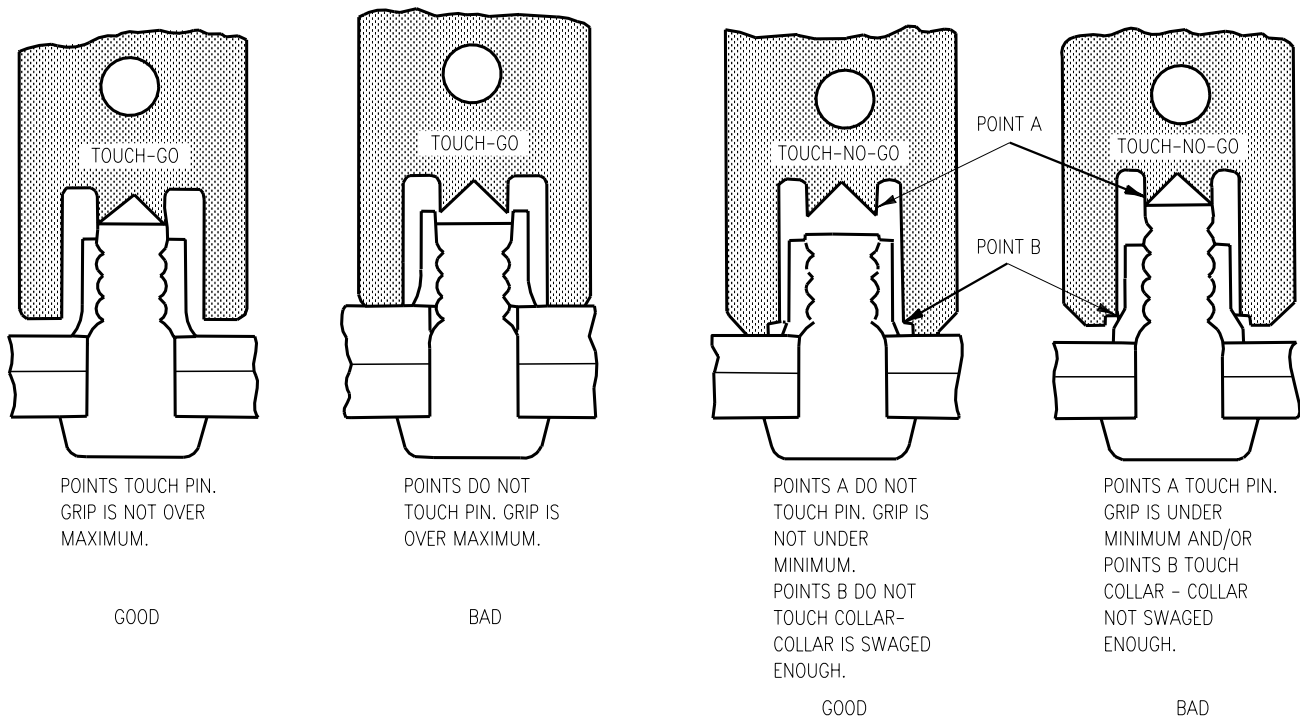


SWAGED
0.7 HEIGHT
MINIMUM
GOOD

Figure 6. Lockbolt Inspection (Sheet 2)



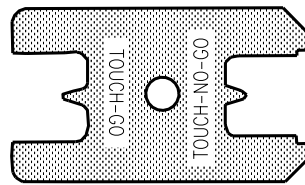
INSTALLED TENSION PULL TYPE FASTENERS



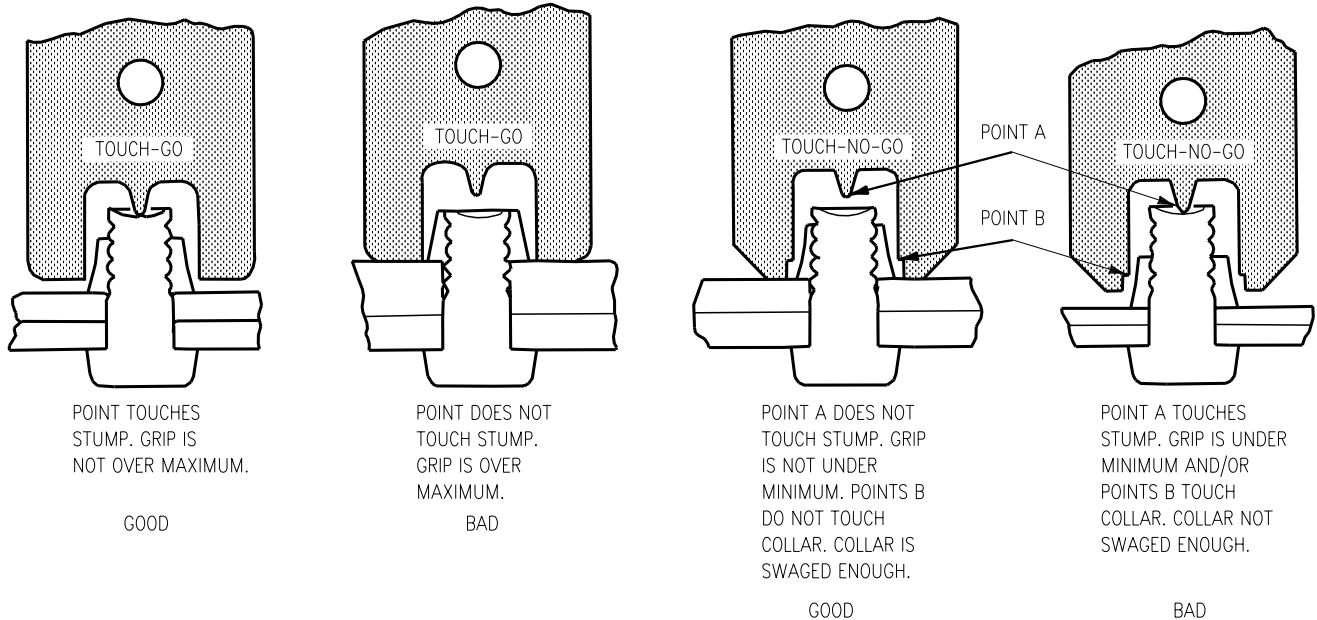
BOTH ENDS OF GAGE
MUST TEST GOOD

GAGE NUMBER	PIN DIAMETER
HG85-2	0.250
HG85-3	0.312
HG85-4	0.375

Figure 6. Lockbolt Inspection (Sheet 3)



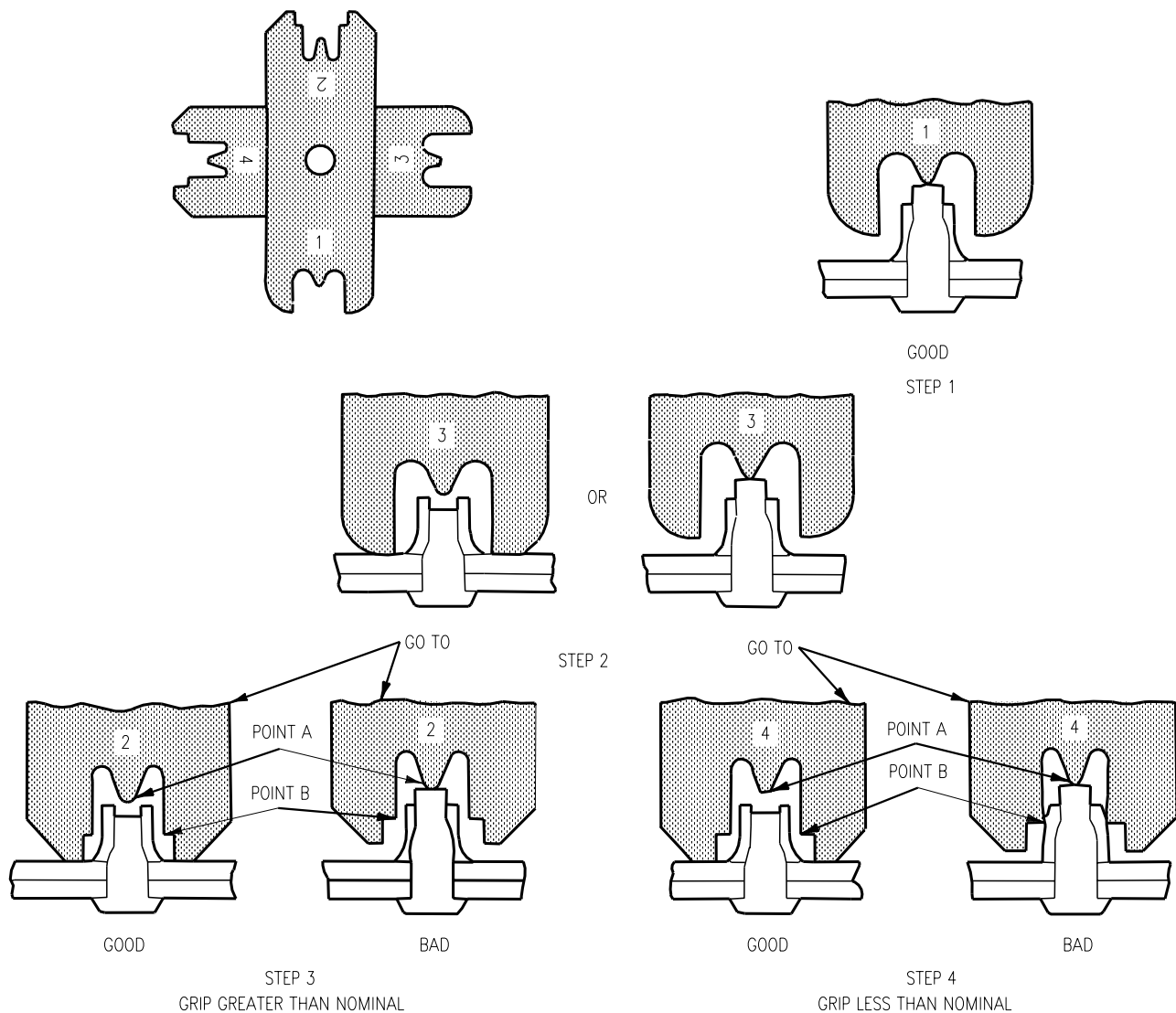
INSTALLED SHEAR AND TENSION STUMP TYPE FASTENERS



BOTH ENDS OF GAGE
MUST TEST GOOD

GAGE NUMBER	PIN DIAMETER
HG34D-2	0.187
HG34D-4	0.250
HG34D-6	0.312
HG34D-6	0.375
HG75-1	0.187
HG75-2	0.250
HG75-3	0.312
HG75-4	0.375
HG75-5	0.156
HG75-8	0.156

Figure 6. Lockbolt Inspection (Sheet 4)



BOTH STEPS 1 AND 3 OR
STEPS 4 MUST TEST GOOD

GAGES HG75-6 AND HG75-7

STEP 1: POINT TOUCHES STUMP,
GRIP IS NOT OVER
MAXIMUM. GOOD

STEP 2: IF POINT DOES NOT TOUCH
STUMP, GO TO STEP 3.
IF POINT TOUCHES STUMP,
GO TO STEP 4.

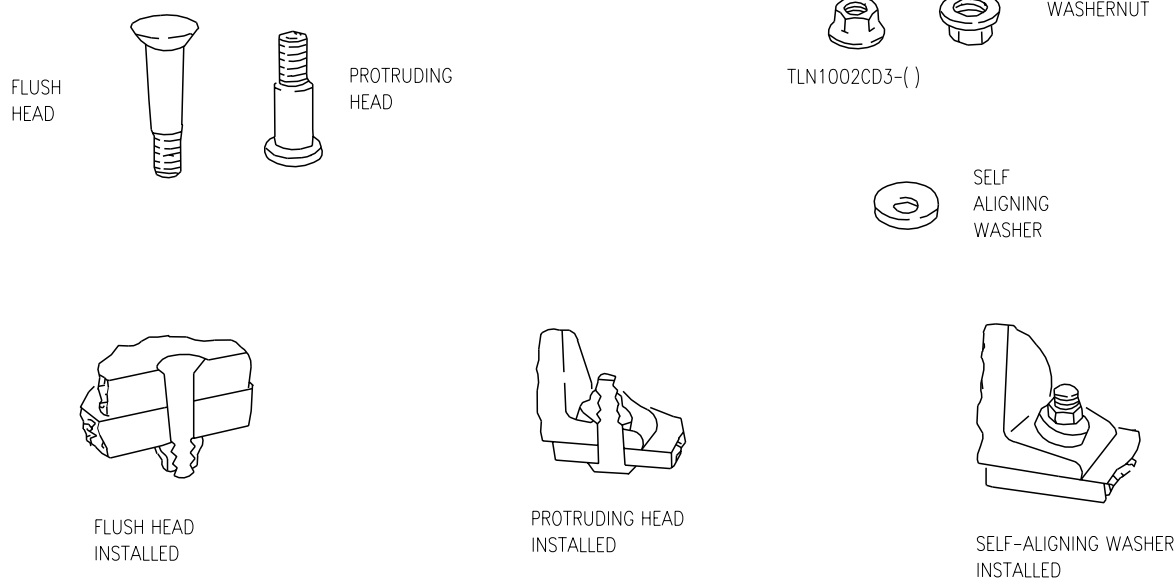
STEP 3: POINT A DOES NOT TOUCH
STUMP. GRIP IS NOT UNDER
MINIMUM. POINTS B DO NOT
TOUCH COLLAR, COLLAR
SWAGED ENOUGH. GOOD

POINT A TOUCHES STUMP,
GRIP IS UNDER MINIMUM
AND/OR POINTS B TOUCH
COLLAR. COLLAR NOT
SWAGED ENOUGH. BAD

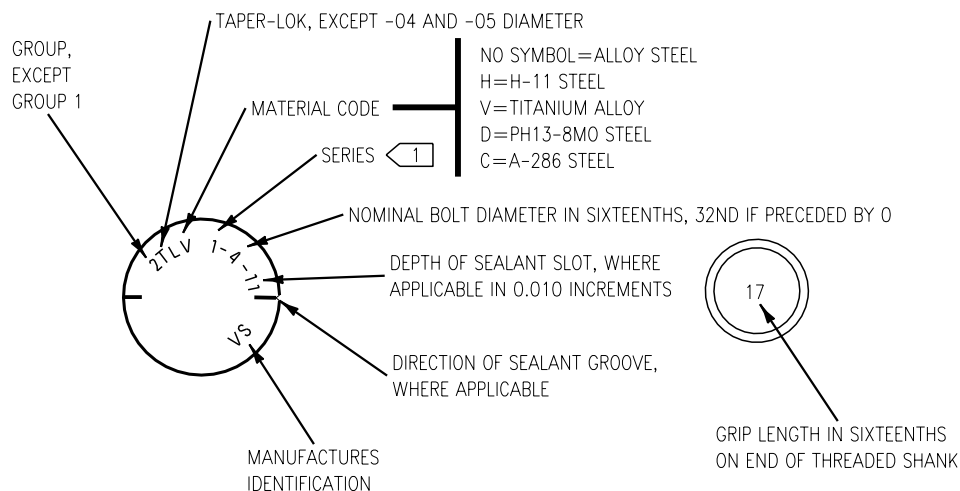
STEP 4: SAME PROCEDURE AS
STEP 3 EXCEPT USE SIDE
4 OF GAGE.

GAGE NUMBER	PIN DIAMETER
HG75-6	0.125
HG75-7	0.125

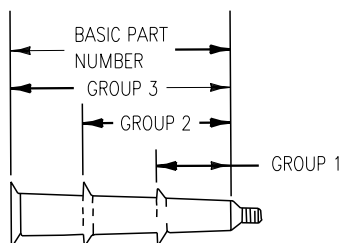
Figure 6. Lockbolt Inspection (Sheet 5)



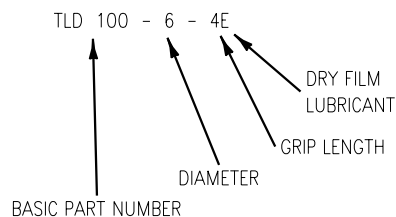
HEAD MARKINGS



GROUPS



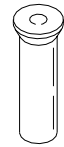
TAPER-LOK PIN



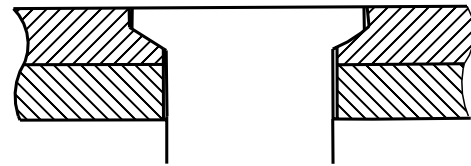
LEGEND

1 SERIES NO. TDL100, C6/C7 DIA.

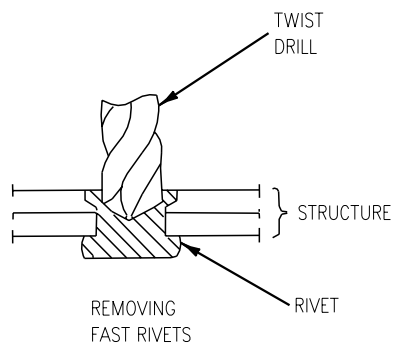
Figure 7. Taper-Lok Identification



FAST RIVET
3M1022

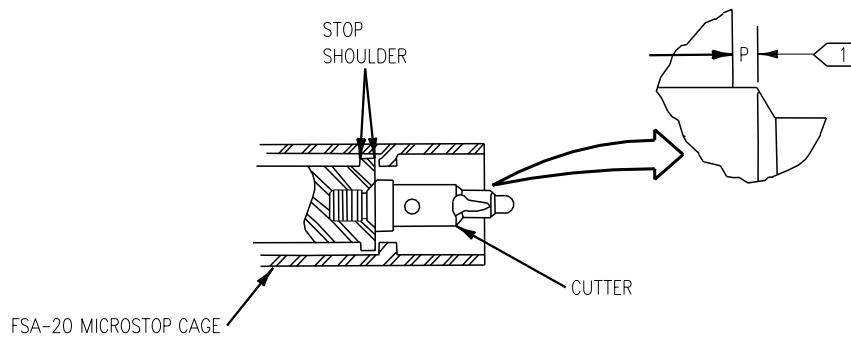


INSTALLED
FAST RIVET



LEGEND

1 "P" OCCURS WHEN STOP SHOULDER IS BOTTOMED OUT.

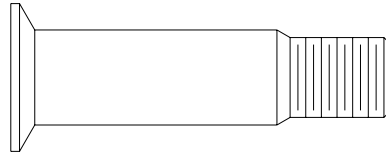
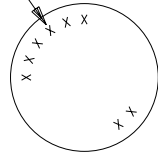


NOMINAL RIVET DIAMETER	P +0.002 -0.000
1/8	0.015
5/32	0.017
3/16	0.021
1/4	0.028

EXAMPLE OF MICROSTOP CAGE AND CUTTER

Figure 8. Fast Rivets

HEAD
MARKING

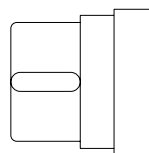
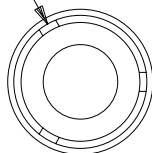


FLUSH HEAD

3M1052 V 4 L 10

- GRIP IN 16THS
- LUBRICANT
- DIAMETER IN 16THS
- MATERIAL:
V = TITANIUM
C = CRES
- BASIC NUMBER

LOBES



COLLAR

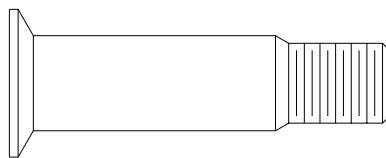
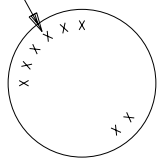
3M972 -3

- DIAMETER IN 16THS
- BASIC NUMBER

TYPE I

Figure 9. Eddie-Bolt and Collar Identification (Sheet 1)

HEAD
MARKING



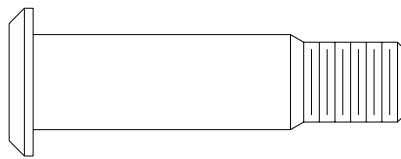
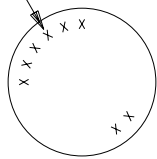
FLUSH HEAD

3M1245 V 4 L 10

- GRIP LENGTH
- LUBRICANT:
L = DRY FILM LUBRICANT
- = CETYL ALCOHOL
- DIAMETER IN 16THS
- MATERIAL:
V = TITANIUM
C = CRES
- BASIC NUMBER:
3M1245 = TENSION HEAD
3M1246 = SHEAR HEAD

TYPE I I

HEAD
MARKING



PROTRUDING HEAD

3M1247 V 4 L 10

GRIP LENGTH

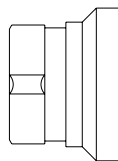
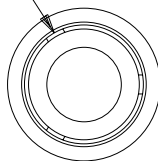
LUBRICANT:
L = DRY FILM LUBRICANT
- = CETYL ALCOHOL

DIAMETER IN 16THS

MATERIAL:
V = TITANIUM
C = CRES

BASIC NUMBER:
3M1247 = SHEAR HEAD
3M1248 = TENSION HEAD

LOBES



COLLAR

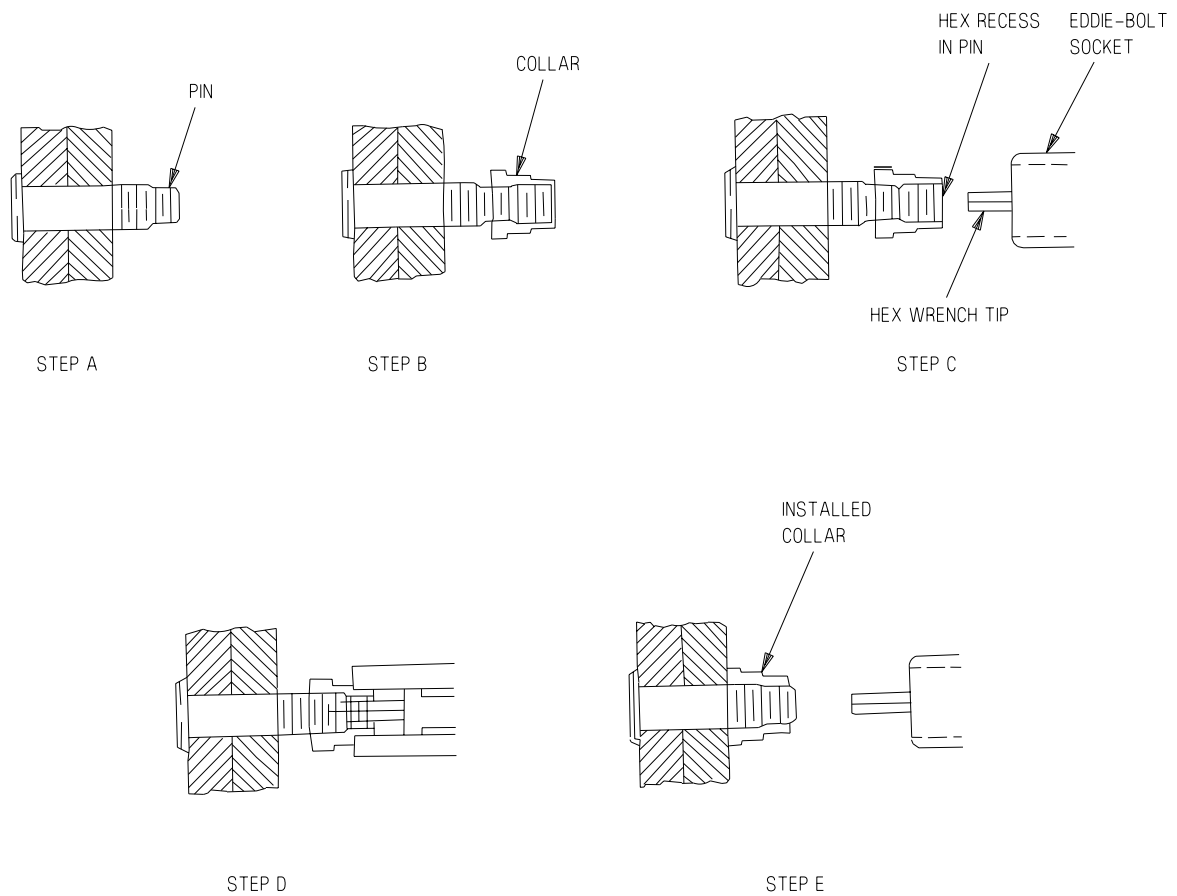
3M1249 V 3

DIAMETER IN 16THS

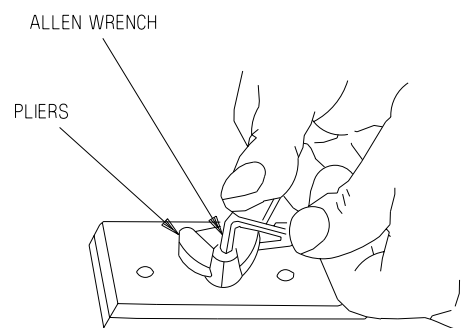
MATERIAL:
N = ALUMINUM
V = TITANIUM
C = CRES

BASIC NUMBER

TYPE I I



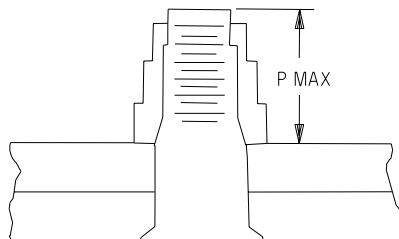
INSTALLATION



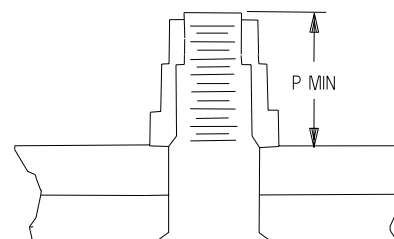
REMOVAL

ADA780-48-1-042

Figure 10. Eddie-Bolt Removal and Installation

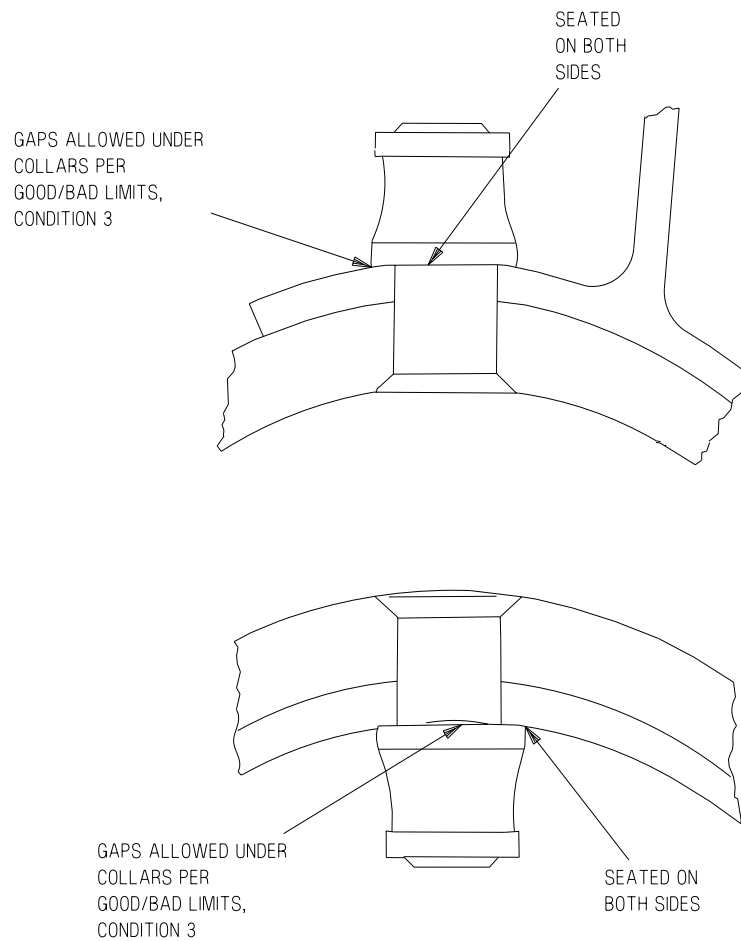


MINIMUM GRIP
(MAXIMUM PROTRUSION)



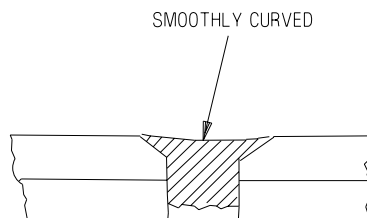
MAXIMUM GRIP
(MINIMUM PROTRUSION)

THREAD PROTRUSION LIMITS

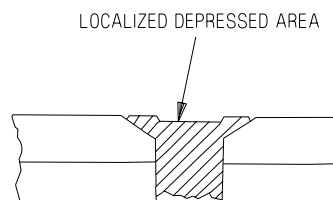


COLLAR SEATED ON CONCAVE SURFACE

GOOD:
EVIDENCE OF A SLIGHT DIPPING
OR BOWING OF HEAD.

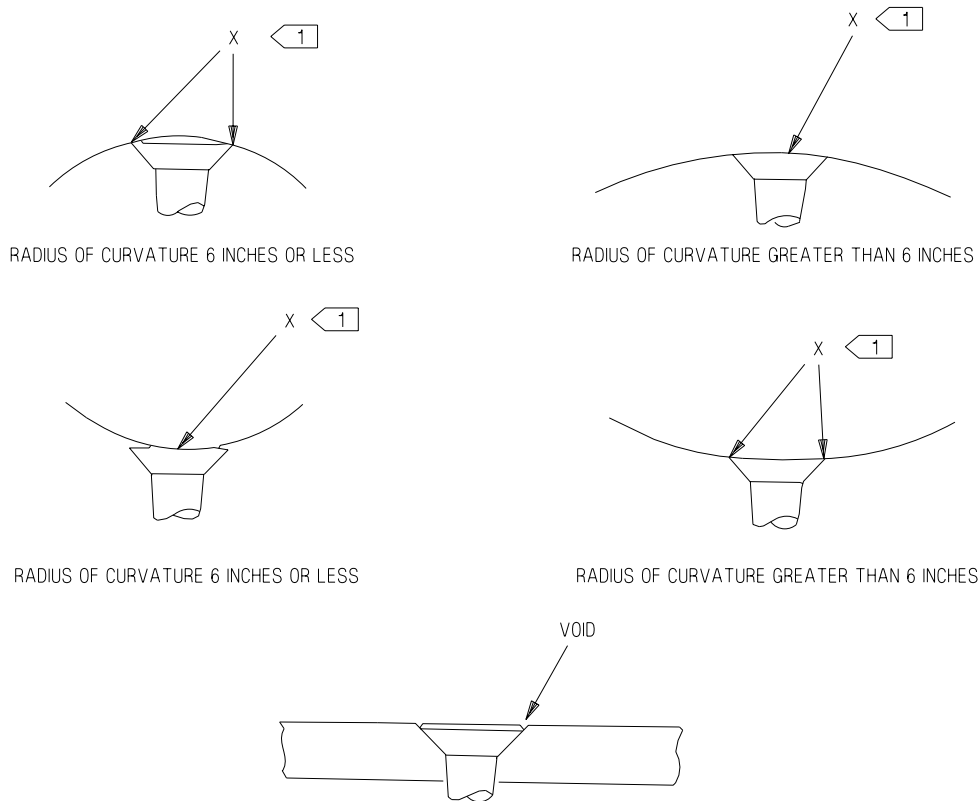


BAD:
EVIDENCE OF DEFORMATION WHICH CAN
BE VISUALLY DETECTED AS A LOCALIZED
DEPRESSED AREA RUNNING PARTLY OR
COMPLETELY AROUND HEAD.



HEAD CONDITION LIMITS

Figure 12. Eddie-Bolt Inspection (Sheet 2)



FLUSHNESS MEASUREMENT

LEGEND

 MEASURE FLUSHNESS AT POINT INDICATED BY "X" (WP008 00)

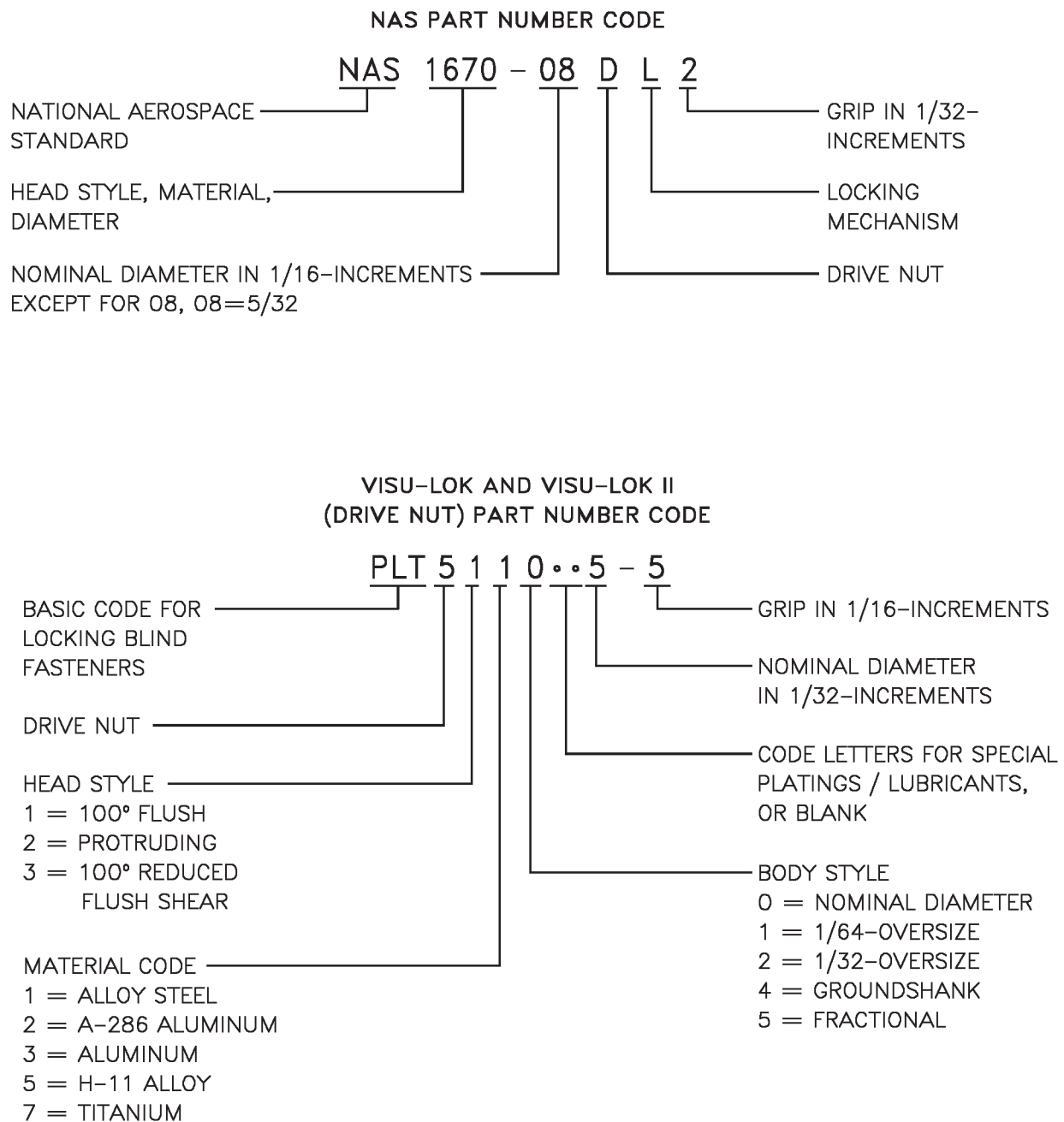


Figure 13. Part Number Code Breakdown

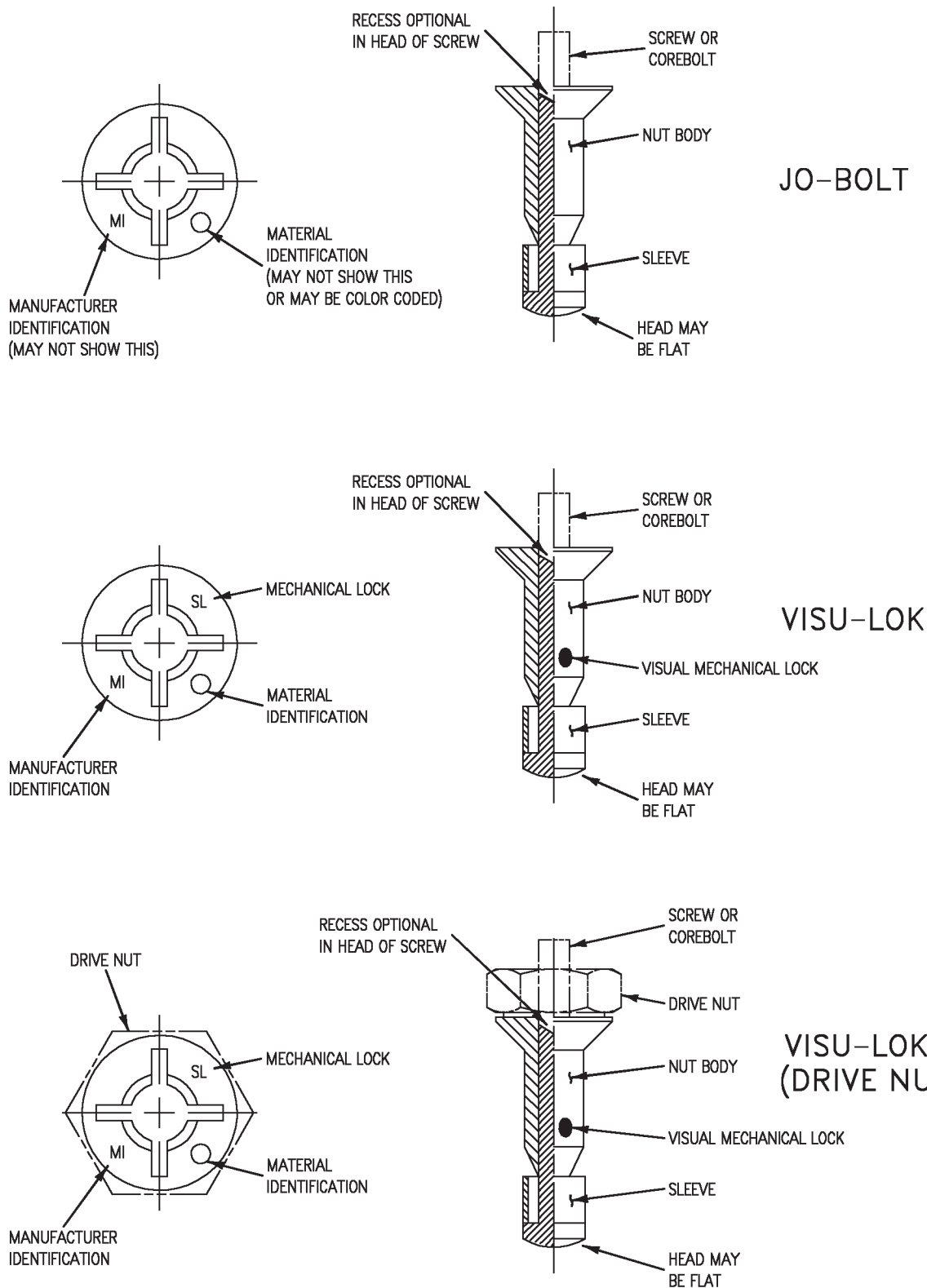
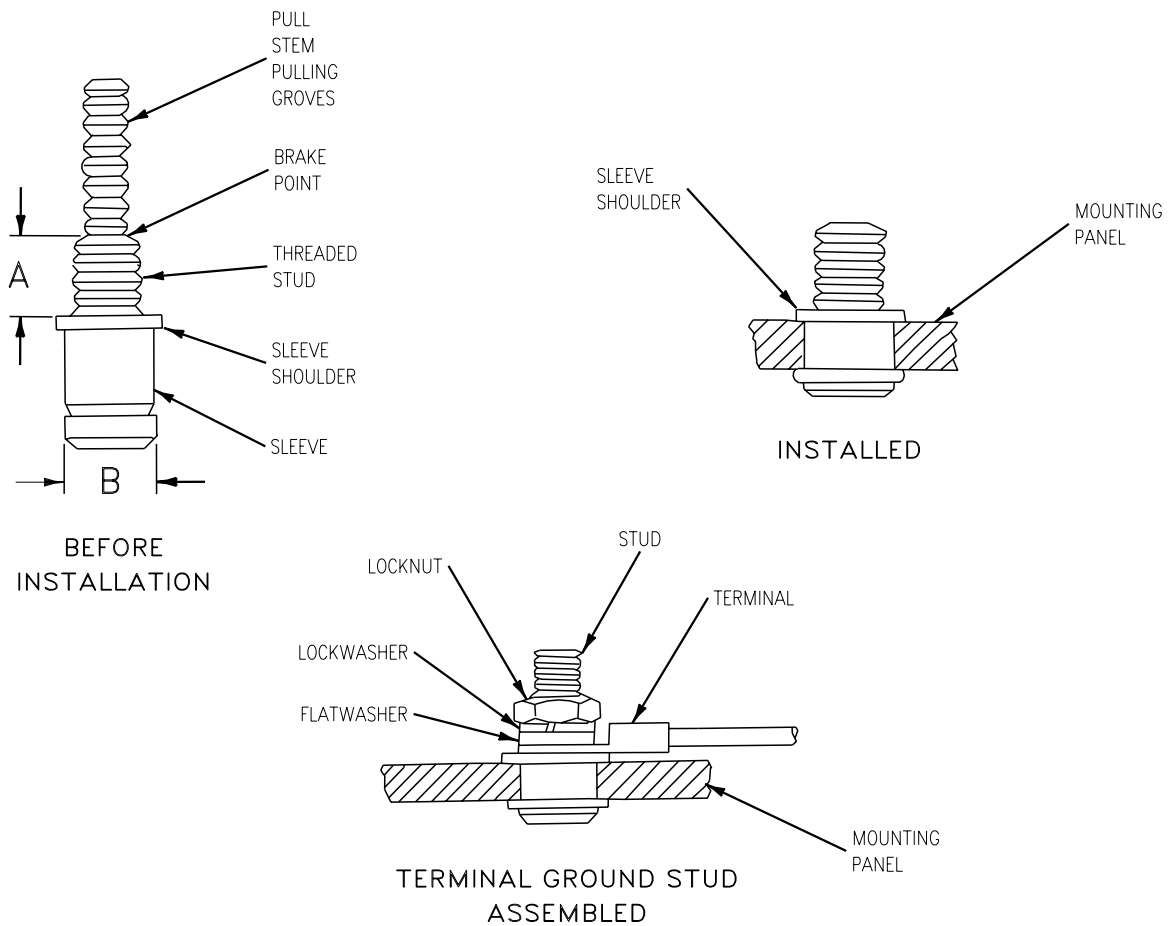


Figure 14. Jo-Bolt / VISU-LOK / VISU-LOK II Identification

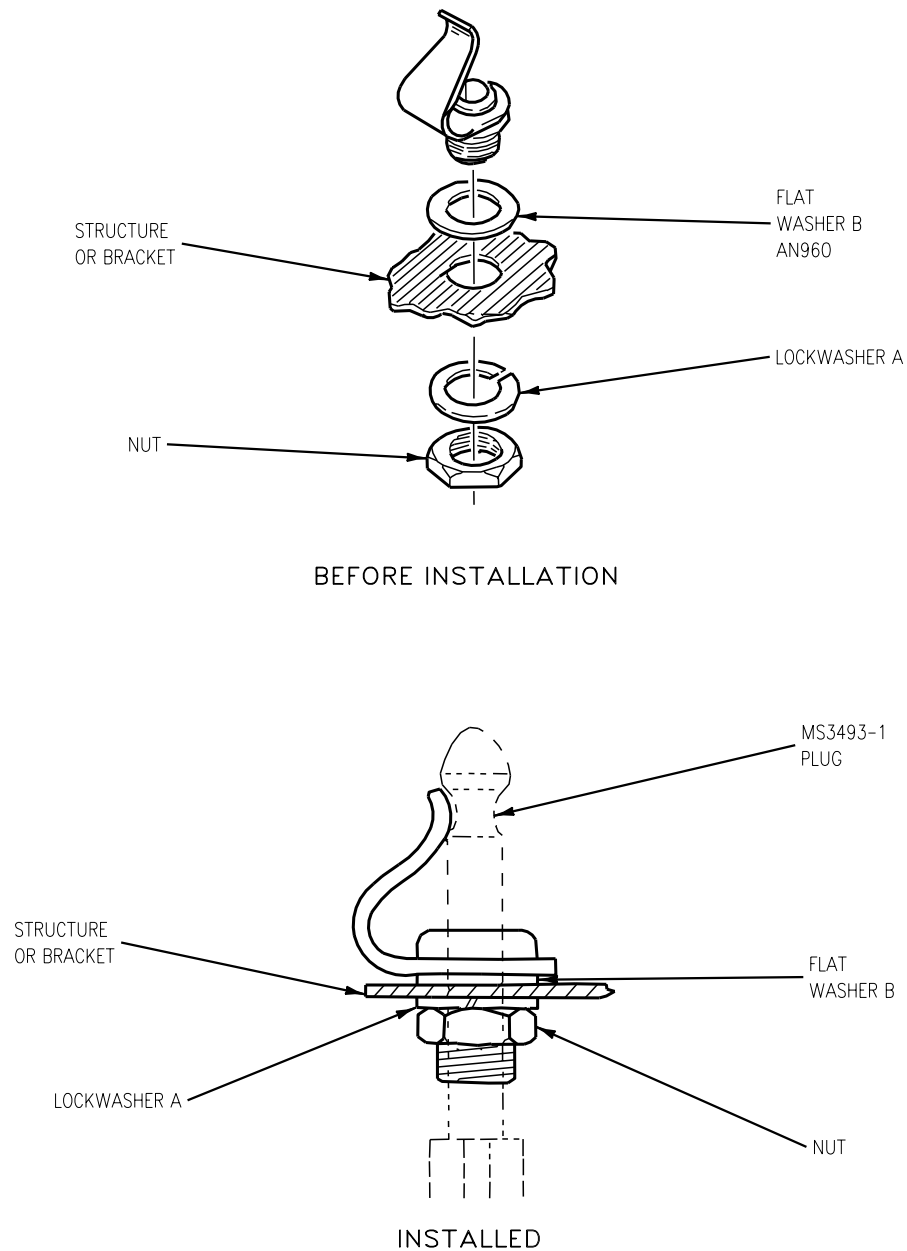



PART NUMBER	A	B (HOLE DIA.)	1 GRIP LENGTH
M83454/04-AA108	0.500	0.3125-0.3165	0.032-0.094
M83454/04-AA110	0.625	0.3125-0.3165	0.032-0.094
M83454/04-AA210	0.625	0.3125-0.3165	0.093-0.157

LEGEND

1 0.032-0.094 STUD COLOR GOLD, 0.093-0.157 STUD COLOR OLIVE DRAB.

Figure 15. Terminal Ground Stud Assembly, MIL-T-83454.



APPROVED CALLOUT	WASHER B	WASHER A	 NUT
ST5M1441-003	AN960-D616	MS35333-76	MS21340-03
ST5M1441-004	AN960-D616L	MS35338-141	MS25082-B20
ST5M1441-005	AN960-D616L	MS35338-141	MS21340-03
ST5M1441-006	AN960-D616L	ST4M148-06002	MS21340-03
ST5M1441-007	AN960-D616L	ST4M148-06002	MS25082-B20

LEGEND


 MS21340 NUT WITH LOCKWIRE HOLES; MS25082 NUT WITHOUT LOCKWIRE HOLES

Figure 16. Grounding Receptacle, ST5M1441.



CLIP NUT
TYPICAL

MCDONNELL STANDARD NO.	EQUIVALENT PART NO.
ST3M523C3M	A11144-7-3
ST3M523C3M-1	A11144-4-3

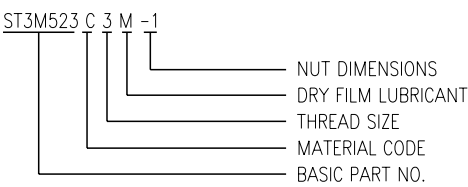
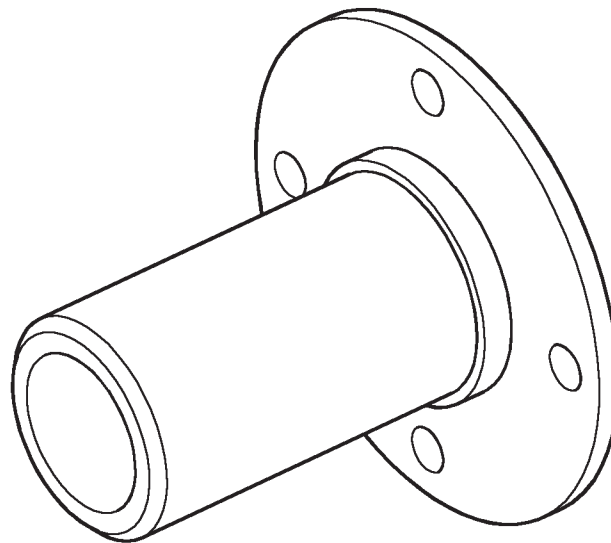
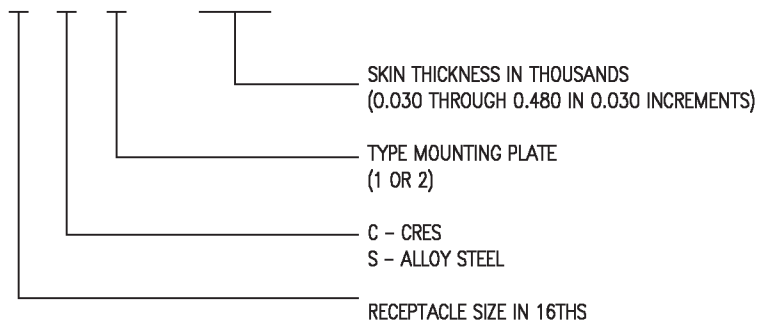


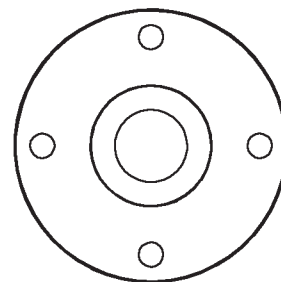
Figure 17. Clip Nut



3M975 - 4 - 1 - 060



TYPE 1



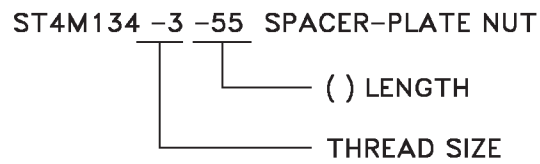
TYPE 2

MOUNTING PLATES

MCDONNELL STANDARD NUMBER	VENDOR NUMBER
3M975-3C1-0.060	52171A3C1-0.060
3M975-3S1-0.060	52171A3S1-0.060

EXAMPLE OF P/N

Figure 18. Quick-Release Pin Receptacle



LENGTH DASH NUMBER	LENGTH L ± 0.010
55	0.55
60	0.60
65	0.65
70	0.70
75	0.75
80	0.80
85	0.85
90	0.90
95	0.95
100	1.00
140	1.40

Figure 19. Spacer-Plate Nut

ORGANIZATIONAL MAINTENANCE
STRUCTURE REPAIR**SHOP PRACTICES****OVERSIZE FASTENERS**

Reference Material

Structural Hardware.....	NAVAIR 01-1A-8
Structure Repair, General Information	A1-F18AC-SRM-200
Fasteners	WP004 06

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Record of Applicable Technical Directives

None

1. DESCRIPTION.

2. Oversize fasteners are listed by standard size; first oversize which is 1/64-inch larger; and second oversize which is 1/32-inch larger. Oversize fasteners listed are the only ones allowed and depot engineering approval is required for any oversize application not covered in this work package.

3. **LOCKBOLTS.** Refer to tables 1 through 4 for oversize Lockbolts; Lockbolts (WP004 06) and (NAVAIR 01-1A-8, Section III), for more lockbolt data.

Table 1. Flush Shear Head Stump Type Lockbolts

Std Dia	Part Number ◀ 7 ▶ ◀ 8 ▶	First Oversize ◀ 7 ▶ ◀ 8 ▶	Second Oversize ◀ 7 ▶ ◀ 8 ▶
5/32	NAS2705V02 thru V16 ◀ 1 ▶	—	NAS2706V02 thru V14 ◀ 1 ▶ ◀ 5 ▶ ◀ 6 ▶ ◀ 9 ▶
3/16	NAS2706V02 thru V14 ◀ 1 ▶	NAS2506V()A-2 thru 13 ◀ 1 ▶	002506V-()-2 thru 13 ◀ 2 ▶
		EB1140N6B()X ◀ 2 ▶ ◀ 3 ▶ ◀ 10 ▶	EB1140N6B()Y ◀ 1 ▶ ◀ 5 ▶ ◀ 6 ▶ ◀ 9 ▶
1/4	NAS2708V03 thru V10 ◀ 1 ▶	NAS2508V()A-2 thru 10 ◀ 1 ▶	002508V-()-2 thru 10 ◀ 1 ▶

Table 1. Flush Shear Head Stump Type Lockbolts (Continued)

Std Dia	Part Number <input type="text" value="7"/> <input type="text" value="8"/>	First Oversize <input type="text" value="7"/> <input type="text" value="8"/>	Second Oversize <input type="text" value="7"/> <input type="text" value="8"/>
		EB1140N8B()X <input type="text" value="2"/> <input type="text" value="3"/> <input type="text" value="10"/>	EB1140N6B()Y <input type="text" value="2"/> <input type="text" value="3"/> <input type="text" value="9"/> <input type="text" value="10"/>
5/16	NAS2710V01 thru V08 <input type="text" value="1"/>	NAS2510V()A-1 thru 8 <input type="text" value="1"/>	002510V-()-1 thru 8 <input type="text" value="1"/>
3/8	NAS2712V02 thru V08 <input type="text" value="1"/>	NAS2512V()A-2 thru 8 <input type="text" value="1"/>	002512V-()-2 thru 8 <input type="text" value="1"/>
5/32	2705MU-4 <input type="text" value="2"/> 2705MU-5 <input type="text" value="2"/>	— —	2706MU-4 <input type="text" value="2"/> <input type="text" value="5"/> <input type="text" value="6"/> 2706MU-5 <input type="text" value="2"/> <input type="text" value="5"/> <input type="text" value="6"/>
3/16	2706MU-3 thru 7 <input type="text" value="2"/> 2706MU-10 <input type="text" value="2"/> 2706MU-11 <input type="text" value="2"/>	81442C06-3 thru 7 <input type="text" value="2"/> 81442C06-10 <input type="text" value="2"/> 81442C06-11 <input type="text" value="2"/>	81443C06-3 thru 7 <input type="text" value="2"/> <input type="text" value="4"/> 81443C06-10 <input type="text" value="2"/> <input type="text" value="4"/> 81443C06-11 <input type="text" value="2"/> <input type="text" value="4"/>
		EB1140N6B()X <input type="text" value="2"/> <input type="text" value="10"/>	EB1140N6B()Y <input type="text" value="2"/> <input type="text" value="9"/>
1/4	2708MU-5 <input type="text" value="2"/> 2708MU-6 <input type="text" value="2"/>	81442C08-5 <input type="text" value="2"/> 81442C08-6 <input type="text" value="2"/>	81443C08-5 <input type="text" value="2"/> <input type="text" value="4"/> 81443C08-6 <input type="text" value="2"/> <input type="text" value="4"/>
		EB1140N8B()X <input type="text" value="2"/> <input type="text" value="10"/>	EB1140N78B()Y <input type="text" value="2"/> <input type="text" value="9"/> <input type="text" value="10"/>
5/16	2710MU-1 thru 16 <input type="text" value="2"/>	81442C10-1 thru 16 <input type="text" value="2"/>	81443C10-1 thru 16 <input type="text" value="2"/> <input type="text" value="4"/>
3/8	2712MU-1 thru 16 <input type="text" value="2"/>	81442C12-1 thru 16 <input type="text" value="2"/>	81443C12-1 thru 16 <input type="text" value="2"/> <input type="text" value="4"/>

NOTES

- 6AL-4V Titanium.
- PH13-8MO CRES.
- Requires engineering approval for nonmagnetic applications.
- Enlarge countersink up to 0.031.
- Countersink depth shall not exceed 70 percent of countersink sheet thickness. Enlarge countersink as required to meet contour smoothness.
- Use one size larger collar.

Table 1. Flush Shear Head Stump Type Lockbolts (Continued)

Std Dia	Part Number <input type="text" value="7"/> <input type="text" value="8"/>	First Oversize <input type="text" value="7"/> <input type="text" value="8"/>	Second Oversize <input type="text" value="7"/> <input type="text" value="8"/>
<input type="text" value="7"/>	See tables 28 and 29 for hole size.		
<input type="text" value="8"/>	See table 30 for hole size.		
<input type="text" value="9"/>	If nonthreaded part of bolt extends through structure, install washer(s) between collar and structure. Adjust washer thickness in increments of 0.016 to provide minimum overlap of thread. Use AN960JD washers with aluminum collars and AN960C washers with CRES collars. Inside dia. of added washer(s) to be reamed to oversize hole dia. plus 0.015, see tables 28, 29 and 30. Corrosion and dissimilar metal protection of washers shall be same as requirements of collar.		
<input type="text" value="10"/>	For oversize Eddie-Bolt pins, use applicable size EB73 collars. This oversize replacement is not to be used for fasteners with collar materials other than aluminum.		

Table 2. Protruding Head Stump Type Lockbolts

Std Dia	Part Number <input type="text" value="5"/> <input type="text" value="6"/>	First Oversize <input type="text" value="5"/> <input type="text" value="6"/>	Second Oversize <input type="text" value="5"/> <input type="text" value="6"/>
5/32	NAS2605V2 thru V13 <input type="text" value="1"/>	—	NAS2606V2 thru V13 <input type="text" value="1"/> <input type="text" value="4"/>
3/16	NAS2606V2 thru V10 <input type="text" value="1"/>	NAS2406V()A-2 thru 10 <input type="text" value="1"/>	002406V-2 thru 10 <input type="text" value="1"/>
		EB1440N6()BX <input type="text" value="2"/> <input type="text" value="3"/> <input type="text" value="7"/>	EB1440N6()BY <input type="text" value="2"/> <input type="text" value="3"/> <input type="text" value="7"/> <input type="text" value="8"/>
1/4	NAS2608V2 thru V10 <input type="text" value="1"/>	NAS2408V()A-2 thru 10 <input type="text" value="1"/>	002408V-2 thru 10 <input type="text" value="1"/> <input type="text" value="4"/>
		EB1140N8()BX <input type="text" value="2"/> <input type="text" value="3"/> <input type="text" value="7"/>	EB1440N8()BY <input type="text" value="2"/> <input type="text" value="3"/> <input type="text" value="7"/> <input type="text" value="8"/>
5/16	NAS2610V2 thru V15 <input type="text" value="1"/>	NAS2410V()A-2 thru 15 <input type="text" value="1"/>	002410V-2 thru 15 <input type="text" value="1"/>
3/8	NAS2612V2 thru V15 <input type="text" value="1"/>	NAS2412V()A-2 thru 15 <input type="text" value="1"/>	002412V-2 thru 15 <input type="text" value="1"/>
5/32	2605MU-3 <input type="text" value="2"/>	—	2606MU-3 <input type="text" value="2"/> <input type="text" value="3"/>
3/16	2606MU-3 thru 19 <input type="text" value="2"/>	81440C-6-3 thru 19 <input type="text" value="2"/>	81441C-6-3 thru 19 <input type="text" value="2"/>
		EB1440N6()BX <input type="text" value="2"/> <input type="text" value="3"/> <input type="text" value="7"/>	EB1440N6()BY <input type="text" value="2"/> <input type="text" value="3"/> <input type="text" value="7"/> <input type="text" value="8"/>

Table 2. Protruding Head Stump Type Lockbolts (Continued)

Std Dia	Part Number <input type="text" value="5"/> <input type="text" value="6"/>	First Oversize <input type="text" value="5"/> <input type="text" value="6"/>	Second Oversize <input type="text" value="5"/> <input type="text" value="6"/>
1/4	2608MU-2 thru 6 <input type="text" value="2"/>	81440C-8-2 thru 6 <input type="text" value="2"/>	81441C-8-2 thru 6 <input type="text" value="2"/>
		EB1440N8()BX <input type="text" value="2"/> <input type="text" value="3"/> <input type="text" value="7"/>	EB1440N8()BY <input type="text" value="2"/> <input type="text" value="3"/> <input type="text" value="7"/> <input type="text" value="8"/>
5/16	2610MU-2 thru 8 <input type="text" value="2"/>	81440C-10-2 thru 8 <input type="text" value="2"/>	81441C-10-2 thru 8 <input type="text" value="2"/>
3/8	2610MU-2 thru 8 <input type="text" value="2"/>	81440C-12-2 thru 8 <input type="text" value="2"/>	81441C-10-2 thru 8 <input type="text" value="2"/>

NOTES

- 6AL-4V Titanium.
- PH13-8MO CRES.
- Requires engineering approval for nonmagnetic applications.
- Use one size larger collar.
- See tables 28 and 29 for hole size.
- See table 30 for hole size.
- For oversize Eddie-Bolt pins, use applicable size EB73 collars. This oversize replacement is not to be used for fasteners with collar materials other than aluminum.
- If nonthreaded part of bolt extends through structure, install washer(s) between collar and structure. Adjust washer thickness in increments of 0.016 to provide minimum overlap of thread. Use AN960JD washers with aluminum collars and AN960C washers with CRES collars. Inside dia. of added washer(s) to be reamed to oversize hole dia. plus 0.015, see tables 28, 29 and 30. Corrosion and dissimilar metal protection of washers shall be same as requirements of collar.

Table 3. Flush Head Pull Type Lockbolts

Std Dia	Part Number <input type="text" value="1"/> <input type="text" value="7"/> <input type="text" value="8"/>	First Oversize <input type="text" value="2"/> <input type="text" value="3"/>	Second Oversize
5/32	VLB240-5-3 thru 14	—	VLB145-06-3 thru 14 <input type="text" value="1"/> <input type="text" value="5"/> <input type="text" value="6"/>
3/16	VLB145-06-3 thru 14	81442C-6-3 thru 14	81443C-6-3 thru 14 <input type="text" value="2"/> <input type="text" value="3"/>
		EB1140N6B()X <input type="text" value="9"/> <input type="text" value="10"/>	EB1140N6B()Y <input type="text" value="2"/> <input type="text" value="3"/> <input type="text" value="9"/> <input type="text" value="10"/>

Table 3. Flush Head Pull Type Lockbolts (Continued)

Std Dia	Part Number <input type="text" value="1"/> <input type="text" value="7"/> <input type="text" value="8"/>	First Oversize <input type="text" value="2"/> <input type="text" value="3"/>	Second Oversize
1/4	VLB145-08-5 thru 12	81442C-8-5 thru 12 EB1140N8B()X <input type="text" value="9"/> <input type="text" value="10"/>	81443C-8-5 thru 12 <input type="text" value="2"/> <input type="text" value="3"/> EB1140N8B()Y <input type="text" value="2"/> <input type="text" value="3"/> <input type="text" value="9"/> <input type="text" value="10"/>
3/16	VLB238-6-3 thru 14	81442C-6-3 thru 14	81443C-6-3 thru 14 <input type="text" value="2"/> <input type="text" value="3"/> <input type="text" value="4"/>
		EB1140N6B()X <input type="text" value="9"/> <input type="text" value="10"/>	EB1140N6B()Y <input type="text" value="2"/> <input type="text" value="3"/> <input type="text" value="9"/> <input type="text" value="10"/>
1/4	VLB238-8-5 thru 12	81442C-8-5 thru 12 EB1140N8B()X <input type="text" value="9"/> <input type="text" value="10"/>	81443C-8-5 thru 12 <input type="text" value="2"/> <input type="text" value="3"/> <input type="text" value="4"/> EB1140N8B()Y <input type="text" value="2"/> <input type="text" value="3"/> <input type="text" value="9"/> <input type="text" value="10"/>
5/16	VLB238-10-3 thru 6	81442C-10-3 thru 7	81443C-10-3 thru 7 <input type="text" value="2"/> <input type="text" value="3"/> <input type="text" value="4"/>
3/8	VLB238-12-2 thru 8	81442C-12-2 thru 8	81443C-12-2 thru 8 <input type="text" value="2"/> <input type="text" value="3"/> <input type="text" value="4"/>

NOTES

- 6AL-4V Titanium.
- PH13-8MO CRES.
- Requires engineering approval for nonmagnetic applications.
- Enlarge countersink up to 0.031.
- Use one size larger collar.
- Countersink depth shall not exceed 70 percent of countersink sheet thickness. Enlarge countersink as required to meet contour smoothness.
- See table 28 and 29 for hole size.
- See table 30 for hole size.
- If nonthreaded part of bolt extends through structure, install washer(s) between collar and structure. Adjust washer thickness in increments of 0.016 to provide minimum overlap of thread. Use AN960JD washers with aluminum collars and AN960C washers with CRES collars. Inside dia. of added washer(s) to be reamed to oversize hole dia. plus 0.015, see tables 28, 29 and 30. Corrosion and dissimilar metal protection of washers shall be same as requirements of collar.
- For oversize Eddie-Bolt pins, use applicable size EB73 collars. This oversize replacement is not to be used for fasteners with collar materials other than aluminum.

Table 4. Protruding Head Pull Type Lockbolts

Std Dia	Part Number ◀ 5 ▶ ◀ 6 ▶	First ◀ 2 ▶ Oversize ◀ 5 ▶ ◀ 6 ▶	Second Oversize ◀ 5 ▶ ◀ 6 ▶
5/32	VLB244-5-01 thru 08 ◀ 1 ▶	—	VLB237-6-01 thru 08 ◀ 1 ▶ ◀ 3 ▶
3/16	VLB237-6-3 thru 8 ◀ 1 ▶	81440C-6-3 thru 8 ◀ 4 ▶	81441C-6-3 thru 8 ◀ 2 ▶ ◀ 4 ▶
		EB1440N6()BX ◀ 4 ▶	EB1440N6()BY ◀ 2 ▶ ◀ 4 ▶
1/4	VLB237-8-4 thru 8 ◀ 1 ▶	81440C-8-4 thru 8 ◀ 4 ▶	81441C-8-4 thru 8 ◀ 2 ▶ ◀ 4 ▶
		EB1440N8()BX ◀ 4 ▶	EB1440N8()BY ◀ 2 ▶ ◀ 4 ▶
5/16	VLB237-10-4 thru 8 ◀ 1 ▶	81440C-10-4 thru 8 ◀ 4 ▶	81441C-10-4 thru 8 ◀ 2 ▶ ◀ 4 ▶
3/8	VLB237-12-4 thru 8 ◀ 1 ▶	81440C-12-4 thru 8 ◀ 4 ▶	81441C-12-4 thru 8 ◀ 2 ▶ ◀ 4 ▶
3/16	VLB235-6-6 thru 8 ◀ 2 ▶	81440C-6-6 thru 8	81441C-6-6 thru 8 ◀ 2 ▶
		EB1440N6()BX ◀ 7 ▶ ◀ 8 ▶	EB1440N6()BY ◀ 2 ▶ ◀ 7 ▶ ◀ 8 ▶
1/4	VLB235-8-4 thru 6 ◀ 2 ▶	81440C-8-4 thru 6	81441C-8-4 thru 6 ◀ 2 ▶
		EB1440N8()BX ◀ 7 ▶ ◀ 8 ▶	EB1440N8()BY ◀ 2 ▶ ◀ 7 ▶ ◀ 8 ▶
5/16	VLB235-10-10 ◀ 2 ▶	81440C-10-10	81441C-10-10 ◀ 2 ▶
3/8	VLB235-12-4 thru 8 ◀ 2 ▶	81440C-12-4 thru 8	81441C-12-4 thru 8 ◀ 2 ▶

NOTES

- ◀ 1 ▶ 6AL-4V Titanium.
- ◀ 2 ▶ PH13-8MO CRES.
- ◀ 3 ▶ Use one size larger collar.
- ◀ 4 ▶ Requires engineering approval for nonmagnetic applications.
- ◀ 5 ▶ See table 28 and 29 for hole size.
- ◀ 6 ▶ See table 30 for hole size.

Table 4. Protruding Head Pull Type Lockbolts (Continued)

Std Dia	Part Number <input type="text" value="5"/> <input type="text" value="6"/>	First <input type="text" value="2"/> Oversize <input type="text" value="5"/> <input type="text" value="6"/>	Second Oversize <input type="text" value="5"/> <input type="text" value="6"/>
<p><input type="text" value="7"/> If nonthreaded part of bolt extends through structure, install washer(s) between collar and structure. Adjust washer thickness in increments of 0.016 to provide minimum overlap of thread. Use AN960JD washers with aluminum collars and AN960C washers with CRES collars. Inside dia. of added washer(s) to be reamed to oversize hole dia. plus 0.015, see tables 28, 29 and 30. Corrosion and dissimilar metal protection of washers shall be same as requirements of collar.</p> <p><input type="text" value="8"/> For oversize Eddit-Bolt pins, use applicable size EB73 collars. This oversize replacement is not to be used for fasteners with collar materials other than aluminum.</p>			

4. **JO-BOLTS.** Refer to tables 5 through 8 for oversize Jo-Bolts; (NAVAIR 01-1A-8, Section III), for more Jo-Bolt data.

Table 5. Flush Head Jo-Bolts

Std Dia	Part Number <input type="text" value="4"/> <input type="text" value="5"/>	First <input type="text" value="2"/> Oversize <input type="text" value="4"/> <input type="text" value="5"/>	Second <input type="text" value="3"/> Oversize <input type="text" value="4"/> <input type="text" value="5"/>
5/32	PLT170-5-2 thru 11 <input type="text" value="1"/>	NAS1752-08L-2 thru 11	PLT170-6-3 thru 9 <input type="text" value="1"/>
3/16	PLT170-6-3 thru 9 <input type="text" value="1"/>	NAS1752-3L-3 thru 9	—
1/4	PLT170-8-3 thru 8 <input type="text" value="1"/>	NAS1752-4L-3 thru 8	—
5/16	PLT170-10-3 thru 8 <input type="text" value="1"/>	NAS1752-5L-3 thru 8	—
3/8	PLT170-12-4 thru 6 <input type="text" value="1"/>	NAS1752-6L-4 thru 6	—
5/32	NAS1672-08L-2 thru 8 <input type="text" value="2"/>	NAS1752-08L-2 thru 11	NAS1672-3L-2 thru 8 <input type="text" value="2"/>
3/16	NAS1672-3L-2 thru 8 <input type="text" value="2"/>	NAS1752-3L-2 thru 8	—
1/4	NAS1672-4L-3 thru 8 <input type="text" value="2"/>	NAS1752-4L-3 thru 8	—
5/16	NAS1672-5L-4 thru 8 <input type="text" value="2"/>	NAS1752-5L-4 thru 8	—
3/8	NAS1672-6L-4 thru 8 <input type="text" value="2"/>	NAS1752-6L-4 thru 8	—
NOTES			

Table 5. Flush Head Jo-Bolts (Continued)

Std Dia	Part Number <input type="text" value="4"/> <input type="text" value="5"/>	First <input type="text" value="2"/> Oversize <input type="text" value="4"/> <input type="text" value="5"/>	Second <input type="text" value="3"/> Oversize <input type="text" value="4"/> <input type="text" value="5"/>
<input type="text" value="1"/> 6AL-4V Titanium. <input type="text" value="2"/> A-286 Heat Resistant Steel. <input type="text" value="3"/> Countersink depth shall not exceed 70 percent of countersink sheet thickness. Enlarge countersink as required to meet contour smoothness. <input type="text" value="4"/> See table 31 for hole size. <input type="text" value="5"/> See table 32 for hole size.			

Table 6. Flush Shear Head Jo-Bolts

Std Dia	Part Number <input type="text" value="1"/> <input type="text" value="3"/> <input type="text" value="4"/>	First <input type="text" value="1"/> Oversize <input type="text" value="3"/> <input type="text" value="4"/>	Second <input type="text" value="1"/> <input type="text" value="2"/> Oversize <input type="text" value="3"/> <input type="text" value="4"/>
5/32	PLT1058-5-2 thru 8	PLT1064-5-2 thru 8	PLT1058-6-2 thru 8
3/16	PLT1058-6-2 thru 11	PLT1064-6-2 thru 11	—
1/4	PLT1058-8-4 thru 12	PLT1064-8-4 thru 12	—
5/16	PLT1058-10-4 thru 8	PLT1064-10-4 thru 8	—
3/8	PLT1058-12-4 thru 10	PLT1064-12-4 thru 10	—
NOTES <input type="text" value="1"/> 6AL-4V Titanium. <input type="text" value="2"/> Countersink depth shall not exceed 70 percent of countersink sheet thickness. Enlarge countersink as required to meet contour smoothness. <input type="text" value="3"/> See table 31 for hole size. <input type="text" value="4"/> See table 32 for hole size.			

Table 7. Millable Head Jo-Bolts

Std Dia	Part Number <input type="text" value="1"/> <input type="text" value="3"/> <input type="text" value="4"/>	First <input type="text" value="1"/> Oversize <input type="text" value="3"/> <input type="text" value="4"/>	Second <input type="text" value="1"/> <input type="text" value="2"/> Oversize <input type="text" value="3"/> <input type="text" value="4"/>
5/32	NAS1674-08L2 thru 5	NAS1754-08L 2 thru 5	NAS1674-3L2 thru 5
3/16	NAS1674-3L3 thru 6	NAS1754-3L3 thru 6	—
1/4	NAS1674-4L2 thru 8	NAS1754-4L2 thru 8	—
NOTES <input type="text" value="1"/> Aluminum. <input type="text" value="2"/> Countersink depth shall not exceed 70 percent of countersink sheet thickness. Enlarge countersink as required to meet contour smoothness. <input type="text" value="3"/> See table 31 for hole size. <input type="text" value="4"/> See table 32 for hole size.			

Table 8. Protruding Head Jo-Bolts

Std Dia	Part Number ◀ 4 ▶ ◀ 5 ▶	First Oversize ◀ 4 ▶ ◀ 5 ▶	Second Oversize ◀ 4 ▶ ◀ 5 ▶
5/32	PLT270-5-1 thru 4 ◀ 1 ▶	NAS1753-08L-1 thru 4 ◀ 2 ▶	PLT270-6-1 thru 4 ◀ 1 ▶
3/16	PLT270-6-2 thru 7 ◀ 1 ▶	NAS1753-3L2 thru 7 ◀ 2 ▶	—
1/4	PLT270-8-3 thru 6 ◀ 1 ▶	NAS1753-4L3 thru 6 ◀ 2 ▶	—
5/16	PLT270-10-3 thru 8 ◀ 1 ▶	NAS1753-5L3 thru 8 ◀ 2 ▶	—
3/8	PLT270-12-3 thru 8 ◀ 1 ▶	NAS1753-6L3 thru 8 ◀ 2 ▶	—
5/32	NAS1671-08L2 thru 10 ◀ 2 ▶	NAS1753-08L2 thru 10 ◀ 2 ▶	NAS1671-3L2 thru 5 ◀ 2 ▶
3/16	NAS1671-3L2 thru 5 ◀ 2 ▶	NAS1753-3L2 thru 5 ◀ 2 ▶	—
1/4	NAS1671-4L2 thru 6 ◀ 2 ▶	NAS1753-4L2 thru 6 ◀ 2 ▶	—
5/16	NAS1671-5L3 thru 8 ◀ 2 ▶	NAS1753-5L3 thru 8 ◀ 2 ▶	—
3/8	NAS1671-6L3 thru 8 ◀ 2 ▶	NAS1753-6L3 thru 8 ◀ 2 ▶	—
5/32	NAS1673-8L2 thru 5 ◀ 3 ▶	NAS1755-08L2 thru 5 ◀ 3 ▶	NAS1673-3L-3 thru 6 ◀ 3 ▶
3/16	NAS1673-3L3 thru 6 ◀ 3 ▶	NAS1755-3L3 thru 6 ◀ 3 ▶	—
1/4	NAS1673-4L2 thru 5 ◀ 3 ▶	NAS1755-4L2 thru 5 ◀ 3 ▶	—

NOTES

- ◀ 1 ▶ 6AL-6V Titanium.
 ▶ 2 ▶ A-268 Heat Resistant Steel.
 ▶ 3 ▶ Aluminum.
 ▶ 4 ▶ See table 31 for hole size.
 ▶ 5 ▶ See table 32 for hole size.

5. **TAPER LOKS.** Refer to table 9.

Table 9. Taper Loks

Std Dia	Part Number <input type="text" value="1"/> <input type="text" value="2"/> <input type="text" value="3"/>	First Oversize <input type="text" value="1"/> <input type="text" value="2"/> <input type="text" value="3"/>	Second Oversize <input type="text" value="1"/> <input type="text" value="2"/> <input type="text" value="3"/>
3/8	NAS1724-6C-3 thru 12	NAS1725-6C-3 thru 12	TLD130-6-4E thru 9E
7/16	NAS1724-7C-3 thru 16	NAS1725-7C-3 thru 16	TLD130-7-5E thru 12E
NOTES <input type="text" value="1"/> PH13-8MO CRES. <input type="text" value="2"/> See table 31 for hole size. <input type="text" value="3"/> See table 32 for hole size.			

6. **EDDIE-BOLTS.** Refer to table 10.

Table 10. Flush Shear Head Eddie-Bolts

Std Dia	Part Number <input type="text" value="1"/>	First Oversize <input type="text" value="1"/> <input type="text" value="2"/>	Second Oversize <input type="text" value="1"/> <input type="text" value="2"/>
3/16	EB1140N6B2 thru 10	EB1140N6B2X thru 10X	EB1140N6B2Y thru 10Y <input type="text" value="3"/> <input type="text" value="4"/>
1/4	EB1140N8B2 thru 12	EB1140N8B2X thru 12X	EB1140N8B2Y thru 12Y <input type="text" value="3"/> <input type="text" value="4"/>
NOTES <input type="text" value="1"/> PH13-8MO CRES. <input type="text" value="2"/> Requires engineering approval for nonmagnetic applications. <input type="text" value="3"/> If nonthreaded part of bolt extends through structure, install washer(s) between collar and structure. Adjust washer thickness in increments of 0.016 to provide minimum overlap of thread. Use AN960JD washers with aluminum collars and AN960C washers with CRES collars. Inside dia. of added washer(s) to be reamed to oversize hole dia. plus 0.015, see tables 28, 29 and 30. Corrosion and dissimilar metal protection of washers shall be same as requirements of collar. <input type="text" value="4"/> For oversize Eddit-Bolt pins, use applicable size EB73 collars. This oversize replacement is not to be used for fasteners with collar materials other than aluminum.			

7. **HI-LOKS.** Refer to tables 11 through 17 for oversize fasteners; Hi-Loks (WP004 06),

(NAVAIR 01-1A-8, Section III), for more Hi-Lok data.

Table 11. Flush Shear Head Hi-Loks

Std Dia	Part Number	First Oversize <input type="text" value="2"/> <input type="text" value="4"/>	Second Oversize
5/32	HLT311TB-5-2 thru 12 <input type="text" value="1"/>	—	HLT311TB-6-2 thru 12 <input type="text" value="1"/> <input type="text" value="5"/> <input type="text" value="6"/>

Table 11. Flush Shear Head Hi-Loks (Continued)

Std Dia	Part Number	First Oversize ◀ 2 ▶ ◀ 4 ▶	Second Oversize
3/16	HLT311TB-6-2 thru 12 ◀ 1 ▶	HLT151DL-6-2 thru 12 ◀ 3 ▶	HLT251DL-6-2 thru 12 ◀ 2 ▶ ◀ 3 ▶ ◀ 4 ▶ ◀ 7 ▶
1/4	HLT311TB-8-2 thru 14 ◀ 1 ▶	HLT151DL-8-2 thru 14 ◀ 3 ▶	HLT251DL-8-2 thru 14 ◀ 2 ▶ ◀ 3 ▶ ◀ 4 ▶ ◀ 7 ▶
5/16	HLT311TB-10-2 thru 17 ◀ 1 ▶	HLT151DL-10-2 thru 17 ◀ 3 ▶	HLT251DL-10-2 thru 17 ◀ 2 ▶ ◀ 3 ▶ ◀ 4 ▶ ◀ 7 ▶
3/8	HLT311TB-12-7 thru 16 ◀ 1 ▶	HLT151DL-12-7 thru 16 ◀ 3 ▶	HLT251DL-12-7 thru 16 ◀ 2 ▶ ◀ 3 ▶ ◀ 4 ▶ ◀ 7 ▶
5/32	HLT51YC-5-2 thru 9 ◀ 2 ▶	—	HLT51YC-6-2 thru 9 ◀ 2 ▶ ◀ 5 ▶ ◀ 6 ▶
3/16	HLT51YC-6-2 thru 8 ◀ 2 ▶	HLT151DL-6-2 thru 8	HLT251DL-6-2 thru 8 ◀ 2 ▶ ◀ 4 ▶ ◀ 7 ▶
1/4	HLT51YC-8-4 thru 11 ◀ 2 ▶	HLT151DL-8-4 thru 11	HLT251DL-8-4 thru 11 ◀ 2 ▶ ◀ 4 ▶ ◀ 7 ▶
5/16	HLT51YC-10-8 thru 18 ◀ 2 ▶	HLT151DL-10-8 thru 18	HLT251DL-10-8 thru 18 ◀ 2 ▶ ◀ 4 ▶ ◀ 7 ▶
3/8	HLT51YC-12-7 thru 9 ◀ 2 ▶	HLT151DL-12-7 thru 9	HLT251DL-12-7 thru 9 ◀ 2 ▶ ◀ 4 ▶ ◀ 7 ▶

NOTES

◀ 1 ▶ 6AL-4V Titanium.

◀ 2 ▶ PH13-8MO CRES.

◀ 3 ▶ Requires engineering approval for nonmagnetic applications.

◀ 4 ▶ If nonthreaded part of pin extends through structure, install washer(s) between collar and structure. Adjust washer thickness in increments of 0.016 to provide minimum overlap of thread. Use AN960JD washers with aluminum collars and AN960C washers with CRES collars. Inside dia. of added washer(s) to be reamed to oversize hole dia. plus 0.015, see tables 28, 29 and 30. Corrosion and dissimilar metal protection of washers shall be same as requirements of collar.

◀ 5 ▶ Countersink depth shall not exceed 70 percent of countersink sheet thickness. Enlarge countersinks as required to meet contour smoothness.

Table 11. Flush Shear Head Hi-Loks (Continued)

Std Dia	Part Number	First Oversize <input type="text" value="2"/> <input type="text" value="4"/>	Second Oversize
<input type="text" value="6"/>	Use one size larger collar.		
<input type="text" value="7"/>	Enlarge countersink up to 0.031.		

Table 12. Flush Tension Head Hi-Loks

Std Dia	Part Number	First Oversize <input type="text" value="2"/> <input type="text" value="4"/>	Second Oversize
5/32	HLT313TB-5-3 thru 9 <input type="text" value="1"/>	—	HLT313TB-6-3 thru 9 <input type="text" value="1"/> <input type="text" value="5"/> <input type="text" value="6"/>
3/16	HLT313TB-6-2 thru 16 <input type="text" value="1"/> HLT313TB-6-20 <input type="text" value="1"/> HLT313TB-6-27 <input type="text" value="1"/> HLT313TB-6-40 <input type="text" value="1"/>	HLT153TB-6-2 thru 16 <input type="text" value="3"/> HLT153TB-6-20 <input type="text" value="3"/> HLT153TB-6-27 <input type="text" value="3"/> HLT153TB-6-40 <input type="text" value="3"/>	HLT253TB-6-2 thru 16 <input type="text" value="2"/> <input type="text" value="3"/> <input type="text" value="4"/> HLT253TB-6-20 <input type="text" value="2"/> <input type="text" value="3"/> <input type="text" value="4"/> HLT253TB-6-27 <input type="text" value="2"/> <input type="text" value="3"/> <input type="text" value="4"/> HLT253TB-6-40 <input type="text" value="2"/> <input type="text" value="3"/> <input type="text" value="4"/>
1/4	HLT313TB-8-4 thru 18 <input type="text" value="1"/>	HLT153TB-8-4 thru 18 <input type="text" value="3"/>	HLT253TB-8-4 thru 18 <input type="text" value="2"/> <input type="text" value="3"/> <input type="text" value="4"/>
5/16	HLT313TB-10-6 thru 22 <input type="text" value="1"/>	HLT153TB-10-6 thru 22 <input type="text" value="3"/>	HLT253TB-10-6 thru 22 <input type="text" value="2"/> <input type="text" value="3"/> <input type="text" value="4"/>
3/8	HLT313TB-12-9 thru 18 <input type="text" value="1"/>	HLT153TB-12-9 thru 18 <input type="text" value="3"/>	HLT253TB-12-9 thru 18 <input type="text" value="2"/> <input type="text" value="3"/> <input type="text" value="4"/>
5/32		—	HLT53YB-6-2 thru 16 <input type="text" value="2"/> <input type="text" value="5"/> <input type="text" value="6"/>
3/16	HLT53YC-6-5 thru 8 <input type="text" value="2"/>	HLT153TB-6-5 thru 8	HLT253TB-6-5 thru 8 <input type="text" value="2"/> <input type="text" value="4"/>
1/4	HLT53YC-8-4 thru 24 <input type="text" value="2"/>	HLT153TB-8-4 thru 24	HLT253TB-8-4 thru 24 <input type="text" value="2"/> <input type="text" value="4"/>
5/16	HLT53YC-10-5 thru 18 <input type="text" value="2"/>	HLT153TB-10-5 thru 18	HLT253TB-10-5 thru 18 <input type="text" value="2"/> <input type="text" value="4"/>

Table 12. Flush Tension Head Hi-Loks (Continued)












Std Dia	Part Number	First Oversize  2  4	Second Oversize
3/8	HLT53YC-12-5 thru 16  2	HLT153TB-12-5 thru 16	HLT253TB-12-5 thru 16  2  4
NOTES  1 6AL-4V Titanium.  2 PH13-8MO CRES.  3 Requires engineering approval for nonmagnetic applications.  4 If nonthreaded part of pin extends through structure, install washer(s) between collar and structure. Adjust washer thickness in increments of 0.016 to provide minimum overlap of thread. Use AN960JD washers with aluminum collars and AN960C washers with CRES collars. Inside dia. of added washer(s) to be reamed to oversize hole dia. plus 0.015, see tables 28, 29 and 30. Corrosion and dissimilar metal protection of washers shall be same as requirements of collar.  5 Countersink depth shall not exceed 70 percent of countersink sheet thickness. Enlarge countersinks as required to meet contour smoothness.  6 Use one size larger collar.			

Table 13. Protruding Shear Head Hi-Loks

































Std Dia	Part Number	First Oversize  2  3	Second Oversize
5/32	HLT310TB-5-2 thru 11  1	—	HLT310TB-6-2 thru 11  1  5
3/16	HLT310TB-6-2 thru 14  1 HLT310TB-6-20  1	HLT152TB-6-2 thru 14 HLT152TB-6-20	HLT252TB-6-2 thru 14  2  3  4 HLT252-TB-6-20  2  3  4
1/4	HLT310TB-8-2 thru 18  1	HLT152TB-8-2 thru 18	HLT252TB-8-2 thru 18  2  3  4
5/16	HLT310TB-10-3 thru 11  1	HLT152TB-10-3 thru 11	HLT252TB-10-3 thru 11  2  3  4
3/8	HLT310TB-12-4 thru 12  1	HLT152TB-12-4 thru 12	HLT252TB-12-4 thru 12  2  3  4
5/32	HLT50YC-5-2 thru 7  2	—	HLT50YC-6-2 thru 7  2  5
3/16	HLT50YC-6-2 thru 8  2	HLT152TB-6-2 thru 8  4	HLT252TB-6-2 thru 8  2  3

Table 13. Protruding Shear Head Hi-Loks (Continued)

Std Dia	Part Number	First Oversize ◀ 2 ▶ ◀ 3 ▶	Second Oversize
1/4	HLT50YC-8-2 thru 15 ◀ 2 ▶ HLT50YC-8-50 ◀ 2 ▶	HLT152TB-8-2 thru 15 ◀ 4 ▶ HLT152TB-8-50 ◀ 4 ▶	HLT252TB-8-2 thru 15 ◀ 2 ▶ ◀ 3 ▶ HLT252TB-8-50 ◀ 2 ▶ ◀ 3 ▶
5/16	HLT50YC-10-2 thru 13 ◀ 2 ▶ HLT50YC-10-17 ◀ 2 ▶	HLT152TB-10-2 thru 13 ◀ 4 ▶ HLT152TB-10-17 ◀ 4 ▶	HLT252TB-10-2 thru 13 ◀ 2 ▶ ◀ 3 ▶ HLT252TB-10-17 ◀ 2 ▶ ◀ 3 ▶
3/8	HLT50YC-12-3 thru 7 ◀ 2 ▶ HLT50YC-12-10 ◀ 2 ▶	HLT152TB-12-3 thru 7 ◀ 4 ▶ HLT152TB-12-10 ◀ 4 ▶	HLT252TB-12-3 thru 7 ◀ 2 ▶ ◀ 3 ▶ HLT252TB-12-10 ◀ 2 ▶ ◀ 3 ▶
NOTES ◀ 1 ▶ 6AL-4V Titanium. ◀ 2 ▶ PH13-8MO CRES. ◀ 3 ▶ If nonthreaded part of pin extends through structure, it is necessary to install washer(s) between collar and structure. Adjust washer thickness in increments of 0.016 to provide minimum overlap of thread. Use AN960JD washers with aluminum collars and AN960C washers with CRES collars. Inside diameter of added washers to be reamed to oversize hole diameter plus 0.015, see tables 28, 29 and 30. Corrosion and dissimilar metal protection of washer shall be same as requirements of collar. ◀ 4 ▶ Requires engineering approval for nonmagnetic applications. ◀ 5 ▶ Use one size larger collar.			

Table 14. Protruding Tension Head Hi-Loks

Std Dia	Part Number	First Oversize ◀ 2 ▶ ◀ 3 ▶	Second Oversize
5/32	HLT312DA-5-2 thru 8 ◀ 1 ▶	—	HLT312DA-6-2 thru 8 ◀ 1 ▶ ◀ 5 ▶
3/16	HLT312DA-6-2 thru 10 ◀ 1 ▶	HLT152TB-6-2 thru 10 ◀ 4 ▶	HLT252TB-6-2 thru 10 ◀ 2 ▶ ◀ 3 ▶ ◀ 4 ▶
1/4	HLT312DA-8-3 thru 20 ◀ 1 ▶	HLT152TB-8-3 thru 20 ◀ 4 ▶	HLT252TB-8-3 thru 20 ◀ 2 ▶ ◀ 3 ▶ ◀ 4 ▶
5/16	HLT312DA-10-3 thru 15 ◀ 1 ▶	HLT152TB-10-3 thru 15 ◀ 4 ▶	HLT252TB-10-3 thru 15 ◀ 2 ▶ ◀ 3 ▶ ◀ 4 ▶

Table 14. Protruding Tension Head Hi-Loks (Continued)

Std Dia	Part Number	First Oversize <input type="text" value="2"/> <input type="text" value="3"/>	Second Oversize
3/8	HLT312DA-12-4 thru 8 <input type="text" value="1"/>	HLT152TB-12-4 thru 8 <input type="text" value="4"/>	HLT252TB-12-4 thru 8 <input type="text" value="2"/> <input type="text" value="3"/> <input type="text" value="4"/>
5/32	HLT52YB-5-2 thru 8 <input type="text" value="2"/>	—	HLT52YB-6-2 thru 13 <input type="text" value="2"/> <input type="text" value="5"/>
3/16	HLT52YB-6-2 thru 13 <input type="text" value="2"/>	HLT152TB-6-2 thru 13	HLT252TB-6-2 thru 13 <input type="text" value="2"/> <input type="text" value="3"/>
1/4	HLT52YB-8-5 thru 18 <input type="text" value="2"/>	HLT152TB-8-5 thru 18	HLT252TB-8-5 thru 18 <input type="text" value="2"/> <input type="text" value="3"/>
5/16	HLT52YB-10-2 thru 14 <input type="text" value="2"/>	HLT152TB-10-2 thru 14	HLT252TB-10-2 thru 14 <input type="text" value="2"/> <input type="text" value="3"/>
3/8	HLT52YB-12-2 thru 10 <input type="text" value="2"/>	HLT152TB-12-2 thru 10	HLT252TB-12-2 thru 10 <input type="text" value="2"/> <input type="text" value="3"/>

NOTES

 6AL-4V Titanium. PH13-8MO CRES.

If nonthreaded part of pin extends through structure, it is necessary to install washer(s) between collar and structure. Adjust washer thickness in increments of 0.016 to provide minimum overlap of thread. Use AN960JD washers with aluminum collars and AN960C washers with CRES collars. Inside diameter of added washers to be reamed to oversize hole diameter plus 0.015, see tables 28, 29 and 30. Corrosion and dissimilar metal protection of washer shall be same as requirements of collar.

 Requires engineering approval for nonmagnetic applications. Use one size larger collar.

Table 15. Flush Shear Head (Short Thread) Hi-Loks

Std Dia	Part Number <input type="text" value="1"/> <input type="text" value="2"/> <input type="text" value="3"/>	First Oversize <input type="text" value="1"/> <input type="text" value="2"/> <input type="text" value="3"/>	Second Oversize <input type="text" value="1"/> <input type="text" value="2"/> <input type="text" value="3"/>
5/32	—	—	HLT49TB-6-4M thru 24M <input type="text" value="4"/> <input type="text" value="5"/>
3/16	HLT49TB-6-4M thru 24M	HLT149TB-6-4 thru 24	HLT249TB-6-4 thru 24 <input type="text" value="6"/>
1/4	HLT49TB-8-6M thru 28M	HLT149TB-8-6 thru 28	HLT249TB-8-6 thru 28 <input type="text" value="6"/>
5/16	HLT49TB-10-6M thru 28M	HLT149TB-10-6 thru 28	HLT249TB-10-6 thru 28 <input type="text" value="6"/>

Table 15. Flush Shear Head (Short Thread) Hi-Loks (Continued)

Std Dia	Part <input type="text" value="1"/> Number <input type="text" value="2"/> <input type="text" value="3"/>	First <input type="text" value="1"/> Oversize <input type="text" value="2"/> <input type="text" value="3"/>	Second <input type="text" value="1"/> Oversize <input type="text" value="2"/> <input type="text" value="3"/>
3/8	HLT49TB-12-8M thru 24M	HLT149TB-12-8 thru 24	HLT249TB-12-8 thru 24 <input type="text" value="6"/>
7/16	HLT49TB-14-8M thru 24M	HLT149TB-14-8 thru 24	HLT249TB-14-8 thru 24 <input type="text" value="6"/>

NOTES

- PH13-8MO CRES.
 See tables 28 and 29 for hole size.
 See table 30 for hole size.
 Countersink depth shall not exceed 70 percent of countersink sheet thickness. Enlarge countersinks as required to meet contour smoothness.
 Use one size larger collar.
 Enlarge countersink up to 0.031.

Table 16. Flush Tension Head (Short Thread) Hi-Loks

Std Dia	Part <input type="text" value="1"/> Number <input type="text" value="2"/> <input type="text" value="3"/>	First <input type="text" value="1"/> Oversize <input type="text" value="2"/> <input type="text" value="3"/>	Second <input type="text" value="1"/> Oversize <input type="text" value="2"/> <input type="text" value="3"/>
5/32	—	—	HLT33TB-6-4M thru 16M <input type="text" value="4"/> <input type="text" value="5"/>
3/16	HLT33TB-6-4M thru 16M	HLT133TB-6-4M thru 16M	HLT233TB-6-4 thru 16
1/4	HLT33TB-8-4M thru 18M HLT33TB-8-10-5M	HLT133TB-8-4M thru 18M HLT133TB-8-10-5M	HLT233TB-8-4 thru 18 HLT233TB-8-10-5
5/16	HLT33TB-10-9M thru 19M	HLT133TB-10-9M thru 19M	HLT233TB-10-9 thru 19
3/8	HLT33TB-12-8M thru 20M	HLT133TB-12-8M thru 20M	HLT233TB-12-8 thru 20
7/16	—	—	—

NOTES

- PH13-8MO CRES.
 See tables 28 and 29 for hole size.
 See table 30 for hole size.
 Countersink depth shall not exceed 70 percent of countersink sheet thickness. Enlarge countersinks as required to meet contour smoothness.
 Use one size larger collar.

Table 17. Flush Tension Head Sealant Injection Hi-Loks

Std Dia	Part Number <input type="text" value="1"/>	First Oversize <input type="text" value="1"/> <input type="text" value="2"/>	Second Oversize <input type="text" value="1"/> <input type="text" value="2"/>
1/4	HLT265TB8-9-30	HLT206TB8-9-30	HLT208TB8-9-30
	HLT265TB8-10-33	HLT206TB8-10-33	HLT208TB8-10-33
	HLT265TB8-10-35	HLT206TB8-10-35	HLT208TB8-10-35
	HLT265TB8-10-39	HLT206TB8-10-39	HLT208TB8-10-39
	HLT265TB8-10-44	HLT206TB8-10-44	HLT208TB8-10-44
	HLT265TB8-11-41	HLT206TB8-11-41	HLT208TB8-11-41
	HLT265TB8-11-46	HLT206TB8-11-46	HLT208TB8-11-46
	HLT265TB8-12-16	HLT206TB8-12-16	HLT208TB8-12-16
	HLT265TB8-12-33	HLT206TB8-13-33	HLT208TB8-13-33
	HLT265TB8-12-34	HLT206TB8-12-34	HLT208TB8-12-34
	HLT265TB8-12-45	HLT206TB8-12-45	HLT208TB8-12-45
	HLT265TB8-12-50	HLT206TB8-12-50	HLT208TB8-12-50
	HLT265TB8-13-45	HLT206TB8-13-45	HLT208TB8-13-45
	HLT265TB8-13-54	HLT206TB8-13-54	HLT208TB8-13-54
	HLT265TB8-14-47	HLT206TB8-14-47	HLT208TB8-14-47
	HLT265TB8-14-54	HLT206TB8-14-54	HLT208TB8-14-54
	HLT265TB8-14-61	HLT206TB8-14-61	HLT208TB8-14-61
	HLT265TB8-14-64	HLT206TB8-14-64	HLT208TB8-14-64
	HLT265TB8-15-48	HLT206TB8-15-48	HLT208TB8-15-48
	HLT265TB8-15-56	HLT206TB8-15-56	HLT208TB8-15-56
	HLT265TB8-15-68	HLT206TB8-15-68	HLT208TB8-15-68
	HLT265TB8-17-57	HLT206TB8-17-57	HLT208TB8-17-57
	HLT265TB8-17-79	HLT206TB8-17-79	HLT208TB8-17-79
	HLT265TB8-18-83	HLT206TB8-18-83	HLT208TB8-18-83
	HLT265TB8-19-86	HLT206TB8-19-86	HLT208TB8-19-86

Table 17. Flush Tension Head Sealant Injection Hi-Loks (Continued)

Std Dia	Part Number <input type="text" value="1"/>	First Oversize <input type="text" value="1"/> <input type="text" value="2"/>	Second Oversize <input type="text" value="1"/> <input type="text" value="2"/>
5/16	HLT265TB10-8-21	HLT206TB10-8-21	HLT208TB10-8-21
	HLT265TB10-8-30	HLT206TB10-8-30	HLT208TB10-8-30
	HLT265TB10-9-33	HLT206TB10-9-33	HLT208TB10-9-33
	HLT265TB10-10-39	HLT206TB10-10-39	HLT208TB10-10-39
	HLT265TB10-11-39	HLT206TB10-11-39	HLT208TB10-11-39
	HLT265TB10-11-43	HLT206TB10-11-43	HLT208TB10-11-43
	HLT265TB10-12-27	HLT206TB10-12-27	HLT208TB10-12-27
	HLT265TB10-12-40	HLT206TB10-12-40	HLT208TB10-12-40
	HLT265TB10-12-49	HLT206TB10-12-49	HLT208TB10-12-49
	HLT265TB10-12-54	HLT206TB10-12-54	HLT208TB10-12-54
	HLT265TB10-13-54	HLT206TB10-13-54	HLT208TB10-13-54
	HLT265TB10-14-43	HLT206TB10-14-43	HLT208TB10-14-43
	HLT265TB10-14-47	HLT206TB10-14-47	HLT208TB10-14-47
	HLT265TB10-14-66	HLT206TB10-14-66	HLT208TB10-14-66
	HLT265TB10-14-78	HLT206TB10-14-78	HLT208TB10-14-78
	HLT265TB10-15-47	HLT206TB10-15-47	HLT208TB10-15-47
	HLT265TB10-15-69	HLT206TB10-15-69	HLT208TB10-15-69
	HLT265TB10-15-70	HLT206TB10-15-70	HLT208TB10-15-70
	HLT265TB10-16-54	HLT206TB10-16-54	HLT208TB10-16-54
	HLT265TB10-16-83	HLT206TB10-16-83	HLT208TB10-16-83
	HLT265TB10-17-60	HLT206TB10-17-60	HLT208TB10-17-60
	HLT265TB10-17-65	HLT206TB10-17-65	HLT208TB10-17-65
	HTL265TB10-17-86	HLT206TB10-17-86	HLT208TB10-17-86
	HLT265TB10-18-54	HLT206TB10-18-54	HLT208TB10-18-54
	HLT265TB10-18-72	HLT206TB10-18-72	HLT208TB10-18-72

Table 17. Flush Tension Head Sealant Injection Hi-Loks (Continued)




































Std Dia	Part Number <input type="text" value="1"/>	First Oversize <input type="text" value="1"/> <input type="text" value="2"/>	Second Oversize <input type="text" value="1"/> <input type="text" value="2"/>
	HLT265TB10-18-87	HLT206TB10-18-87	HLT208TB10-18-87
	HLT265TB10-19-80	HLT206TB10-19-80	HLT208TB10-19-80
	HLT265TB10-20-88	HLT206TB10-20-88	HLT208TB10-20-88
	HLT265TB10-20-107	HLT206TB10-20-107	HLT208TB10-20-107
	HLT265TB10-21-109	HLT206TB10-21-109	HLT208TB10-21-109
3/8	HLT265TB12-8-23	HLT206TB12-8-23	HLT208TB12-8-23
	HLT265TB12-9-31	HLT206TB12-9-31	HLT208TB12-9-31
	HLT265TB12-13-53	HLT206TB12-13-53	HLT208TB12-13-53
	HLT265TB12-17-54	HLT206TB12-17-54	HLT208TB12-17-54
	HLT265TB12-20-59	HLT206TB12-20-59	HLT208TB12-20-59
	HLT265TB12-21-58	HLT206TB12-21-58	HLT208TB12-21-58
7/16	HLT265TB14-() ()	HLT206TB14-() ()	HLT208TB14-() ()
NOTES <input type="text" value="1"/> PH13-8MO CRES. <input type="text" value="2"/> If nonthreaded part of pin extends through structure, install washer(s) between collar and structures. Adjust washer thickness in increments of 0.016 to provide maximum overlap of thread. Use AN960JD washers with aluminum collars and AN960C washers with CRES collars. Inside dia. of added washer(s) to be reamed to oversize hole dia. plus 0.015, see tables 28, 29 and 30. Corrosion and dissimilar metal protection of washers shall be same as requirements of collar.			

8. **BOLTS.** Refer to tables 18 through 27, and table 33 for oversize bolts; and (NAVAIR 01-1A-8, Section V), for more data on bolts.

Table 18. Flush Shear Head Bolts

Std Dia	Part Number	First Oversize <input type="text" value="1"/> <input type="text" value="4"/> <input type="text" value="5"/> <input type="text" value="7"/>	Second Oversize <input type="text" value="1"/> <input type="text" value="4"/> <input type="text" value="5"/> <input type="text" value="7"/>
3/16	HT4024L3-1 thru 10 <input type="text" value="1"/>	HT4016-3-1X thru 10X	HT4016-3-1Y thru 10Y <input type="text" value="3"/>
1/4	HT4024L4-2 thru 14 <input type="text" value="1"/>	HT4016-4-2X thru 14X	HR4016-4-2Y thru 14Y <input type="text" value="3"/>

Table 18. Flush Shear Head Bolts (Continued)

Std Dia	Part Number	First   Oversize  	Second   Oversize  
5/16	HT4024L5-4 thru 13 	HT4016-5-4 thru 13	HT4016-5-4 thru 13 
3/8	HT4024L6-1 thru 8 	HT4016-6-1 thru 8	HT4016-6-1 thru 8 
7/16	HT4024L7-13 thru 19 	HT4016-7-13 thru 19	HT4016-7-13 thru 19 
1/2	HT4024L8-1 thru 8 	HT4016-8-1 thru 8	HT4016-8-1 thru 8 
9/16	HT4024L9-1 thru 8 	HT4016-9-1 thru 8	HT4016-9-1 thru 8 
5/8	HT4024L10-1 thru 8 	HT4016-10-1 thru 8	HT4016-10-1 thru 8 
1/4	HT4028L4-2 thru 12 	HT4016-4-2X thru 12X 	HT4016-4-2Y thru 12Y 
5/16	HT4028L5-4 thru 14 	HT4016-5-4 thru 14 	HT4016-5-4 thru 14 
3/8	HT4028L6-4 thru 16 	HT4016-6-4 thru 16 	HT4016-6-4 thru 16 
7/16	HT4028L7-6 thru 18 	HT4016-7-6 thru 18 	HT4016-7-6 thru 18 
1/2	HT4028L8-6 thru 20 	HT4016-8-6 thru 20 	HT4016-8-6 thru 20 

NOTES





 PH13-8MO CRES 6AL-4V Titanium Enlarge countersink up to 0.031. Requires engineering approval if bolt engages gang channel or plate nut. New nut/spacer installation may be required if oversize bolt shank interferes with nut counterbore. If nonthreaded part of bolt extends through structure, install washer(s) between collar and structure. Adjust washer thickness in increments of 0.016 to provide minimum overlap of thread. Use AN960JD washers with aluminum collars and AN960C washers with CRES collars. Inside dia. of added washer(s) to be reamed to oversize hole dia. plus 0.015, see tables 28, 29 and 30. Corrosion and dissimilar metal protection of washer(s) shall be same as requirements of collar. Requires engineering approval for nonmagnetic applications. For minimum allowable protrusion of bolts through self-locking nuts, see table 33.

Table 19. Flush Tension Head Bolts

Std Dia	Part Number <input type="text" value="4"/> <input type="text" value="5"/>	First <input type="text" value="2"/> Oversize <input type="text" value="4"/> <input type="text" value="5"/>	Second <input type="text" value="2"/> Oversize <input type="text" value="4"/> <input type="text" value="5"/>
3/16	NAS663V2HT thru 22HT <input type="text" value="1"/>	HT4008-3-2 thru 22 <input type="text" value="3"/>	HT4009-3-2 thru 22 <input type="text" value="3"/>
1/4	NAS664V2HT thru 28HT <input type="text" value="1"/>	HT4008-4-2 thru 28 <input type="text" value="3"/>	HT4009-4-2 thru 28 <input type="text" value="3"/>
5/16	NAS665V3HT thru 22HT <input type="text" value="1"/>	HT4008-5-3 thru 22 <input type="text" value="3"/>	HT4009-5-3 thru 22 <input type="text" value="3"/>
3/8	NAS666V10HT thru 16HT <input type="text" value="1"/>	HT4008-6-10 thru 16 <input type="text" value="3"/> <input type="text" value="6"/>	HT4009-6-10 thru 16 <input type="text" value="3"/> <input type="text" value="6"/>
7/16	NAS667V6HT thru 14HT <input type="text" value="1"/>	HT4008-7-6 thru 14 <input type="text" value="3"/>	HT4009-7-6 thru 14 <input type="text" value="3"/>
1/2	NAS668V6HT thru 14HT <input type="text" value="1"/>	HT4008-8-6 thru 14 <input type="text" value="3"/> <input type="text" value="6"/>	HT4009-8-6 thru 14 <input type="text" value="3"/> <input type="text" value="6"/>
3/16	HT4025L3-2 thru 12 <input type="text" value="2"/>	HT4008-3-2 thru 12 <input type="text" value="6"/>	HT4009-3-2 thru 12 <input type="text" value="6"/>
1/4	HT4025L4-5 thru 15 <input type="text" value="2"/> HT4025L4-29 <input type="text" value="2"/>	HT4008-4-5 thru 15 <input type="text" value="6"/> HT4008-4-29	HT4009-4-5 thru 15 <input type="text" value="6"/> HT4009-4-29
5/16	HT4025L5-6 thru 23 <input type="text" value="2"/>	HT4008-5-6 thru 23 <input type="text" value="6"/>	HT4009-5-6 thru 23 <input type="text" value="6"/>
3/8	HT4025L6-13 thru 25 <input type="text" value="2"/>	HT4008-6-13 thru 25 <input type="text" value="6"/>	HT4009-6-13 thru 25 <input type="text" value="6"/>
7/16	HT4025-7-11 thru 26 <input type="text" value="2"/>	HT4008-7-11 thru 26 <input type="text" value="6"/>	HT4009-7-11 thru 26 <input type="text" value="6"/>
1/2	HT4025-8-12 thru 28 <input type="text" value="2"/>	HT4008-8-12 thru 28 <input type="text" value="6"/>	HT4009-8-12 thru 28 <input type="text" value="6"/>
9/16	HT295-9-14 thru 24 <input type="text" value="2"/>	HT4008-9-14 thru 24 <input type="text" value="6"/>	HT4009-9-14 thru 24 <input type="text" value="6"/>
5/8	HT4025-10-14 thru 24 <input type="text" value="2"/>	HT4008-10-14 thru 24 <input type="text" value="6"/>	HT4009-10-14 thru 24 <input type="text" value="6"/>

NOTES

- 6AL-4V Titanium
- PH13-8MO CRES
- Requires engineering approval for nonmagnetic applications.
- Requires engineering approval if bolt engages gang channel or plate nut. New nut/spacer installation may be required if oversize bolt shank interferes with nut counterbore.

Table 19. Flush Tension Head Bolts (Continued)

Std Dia	Part Number <input type="text" value="4"/> <input type="text" value="5"/>	First <input type="text" value="2"/> Oversize <input type="text" value="4"/> <input type="text" value="5"/>	Second <input type="text" value="2"/> Oversize <input type="text" value="4"/> <input type="text" value="5"/>
<input type="text" value="5"/>	If nonthreaded part of bolt extends through structure, install washer(s) between collar and structure. Adjust washer thickness in increments of 0.016 to provide minimum overlap of thread. Use AN960JD washers with aluminum collars and AN960C washers with CRES collars. Inside dia. of added washer(s) to be reamed to oversize hole dia. plus 0.015, see tables 28, 29 and 30. Corrosion and dissimilar metal protection of washer(s) shall be same as requirements of collar.		
<input type="text" value="6"/>	For minimum allowable protrusion of bolts through self-locking nuts, see table 33.		

Table 20. Flush Shear Head (Short Thread) Bolts

Std Dia	Part Number <input type="text" value="1"/>	First <input type="text" value="1"/> Oversize <input type="text" value="2"/> <input type="text" value="3"/>	Second <input type="text" value="1"/> Oversize <input type="text" value="2"/> <input type="text" value="3"/>
3/16	HT4041-3-1-4 HT4041-3-2-4 HT4041-3-2-5 HT4041-3-2-6 HT4041-3-3-5 HT4041-3-5-4 HT4041-3-5-5 HT4041-3-6-5	HT4041-3-1-4X HT4041-3-2-4X HT4041-3-2-5X HT4041-3-2-6X HT4041-3-3-5X HT4041-3-5-4X HT4041-3-5-5X HT4041-3-6-5X	HT4041-3-1-4Y HT4041-3-2-4Y HT4041-3-2-5Y HT4041-3-2-6Y HT4041-3-3-5Y HT4041-3-5-4Y HT4041-3-5-5Y HT4041-3-6-5Y
1/4	HT4041-4-7-5 HT4041-4-9-7 HT4041-4-10-5 HT4041-4-11-5 HT4041-4-11-6 HT4041-4D8-5	HT4041-4-7-5X HT4041-4-9-7X HT4041-4-10-5X HT4041-4-11-5X HT4041-4-11-6X HT4041-4D8-5X	HT4041-4-7-5Y HT4041-4-9-7Y HT4041-4-10-5Y HT4041-4-11-5Y HT4041-4-11-6Y HT4041-4D8-5Y
5/16	HT4041-5-6-6 HT4041-5-10-6 HT4041-5-11-5	HT4041-5-6-6X HT4041-5-10-6X HT4041-5-11-5X	HT4041-5-6-6Y HT4041-5-10-6Y HT4041-5-11-5Y
3/8	HT4041-6-() ()	HT4041-6-() ()X	HT4041-6-() ()Y
7/16	HT4041-7-15-9 HT4041-7-16-9 HT4041-7-17-9	HT4041-7-15-9X HT4041-7-16-9X HT4041-7-17-9X	HT4041-7-15-9Y HT4041-7-16-9Y HT4041-7-17-9Y

NOTES

- PH13-8MO CRES
- Requires engineering approval if bolt engages gang channel or plate nut. New nut/spacer installation may be required if oversize bolt shank interferes with nut counterbore.
- If nonthreaded part of bolt extends through structure, install washer(s) between collar and structure. Adjust washer thickness in increments of 0.016 to provide minimum overlap of thread. Use AN960JD washers with aluminum collars and AN960C washers with CRES collars. Inside dia. of added washer(s) to be reamed to oversize hole dia. plus 0.015, see tables 28, 29 and 30. Corrosion and dissimilar metal protection of washer(s) shall be same as requirements of collar.

Table 21. Flush Tension Head (Short Thread) Bolts

Std Dia	Part Number <input type="text" value="1"/> <input type="text" value="2"/> <input type="text" value="3"/>	First <input type="text" value="1"/> Oversize <input type="text" value="2"/> <input type="text" value="3"/>	Second <input type="text" value="1"/> Oversize <input type="text" value="2"/> <input type="text" value="3"/>
3/16	HT4049-3D28	HT4049-3-28X	HT4049-3-28Y
1/4	HT4049-4-5 thru 11 HT4049-4D14 HT4049-4D28	HT4049-4-5X thru 11X HT4049-4D14X HT4049-4D28X	HT4049-4-5Y thru 11Y HT4049-4-D14Y HT4049-4-D28Y
5/16	HT4049-5-6 thru 13	HT4049-5-6X thru 13X	HT4049-5-6Y thru 13Y
3/8	HT4049-6-12 thru 15	HT4049-6-12X thru 15X	HT4049-6-12Y thru 15Y
7/16	HT4049-7-2 thru 8	HT4049-7-2X thru 8X	HT4049-7-2Y thru 8Y

NOTES

- PH13-8MO CRES
- Requires engineering approval if bolt engages gang channel or plate nut. New nut/spacer installation may be required if oversize bolt shank interferes with nut counterbore.
- If nonthreaded part of pin extends through structure, install washer(s) between collar and structure. Adjust washer thickness in increments of 0.016 to provide minimum overlap of thread. Use AN960JD washers with aluminum collars and AN960C washers with CRES collars. Inside dia. of added washer(s) to be reamed to oversize hole dia. plus 0.015, see tables 28, 29 and 30. Corrosion and dissimilar metal protection of washer(s) shall be same as requirements of collar.

Table 22. Flush Sealing Head Bolts

Std Dia	Part Number	First <input type="text" value="2"/> Oversize <input type="text" value="4"/> <input type="text" value="5"/>	Second <input type="text" value="2"/> Oversize <input type="text" value="4"/> <input type="text" value="5"/>
3/16	HT271-3-2D thru 15D <input type="text" value="1"/> HT271-3-7AS <input type="text" value="1"/>	HT4020-3-2AX thru 15AX <input type="text" value="3"/> HT4020-3-7AX <input type="text" value="3"/>	HT4020-3-2AY thru 15AY <input type="text" value="3"/> HT4020-3-7AY <input type="text" value="3"/>
1/4	HT271-4-7AS thru 20AS <input type="text" value="1"/>	HT4020-4-7AX thru 20AX <input type="text" value="3"/>	HT4020-4-7AY thru 20AY <input type="text" value="3"/>
5/16	HT271-5-9AS thru 22AS <input type="text" value="1"/>	HT4020-5-9AX thru 22AX <input type="text" value="3"/>	HT4020-5-9AY thru 22AY <input type="text" value="3"/>
3/8	HT271-6-13AS thru 21AS <input type="text" value="1"/>	HT4020-6-13AX thru 21AX <input type="text" value="3"/>	HT4020-6-13AY thru 21AY <input type="text" value="3"/>
7/16	HT271-7-8AS thru 24AS <input type="text" value="1"/>	HT4020-7-8AX thru 24AX <input type="text" value="3"/>	HT4020-7-8AY thru 24AY <input type="text" value="3"/>
1/2	HT271-8-10AS thru 22AS <input type="text" value="1"/>	HT4020-8-10AX thru 22AX <input type="text" value="3"/>	HT4020-8-10AY thru 22AY <input type="text" value="3"/>
3/16	HT4020-3-2A thru 18A <input type="text" value="22"/>	HT4020-3-2AX thru 18AX	HT4020-3-2AY thru 18AY

Table 22. Flush Sealing Head Bolts (Continued)

Std Dia	Part Number	First <input type="text" value="2"/> Oversize <input type="text" value="4"/> <input type="text" value="5"/>	Second <input type="text" value="2"/> Oversize <input type="text" value="4"/> <input type="text" value="5"/>
1/4	HT4020-4-2A thru 18A <input type="text" value="2"/>	HT4020-4-2AX thru 18AX	HT4020-4-2AY thru 18AY
5/16	HT4020-5-9A thru 19A <input type="text" value="2"/>	HT4020-5-9AX thru 18AX	HT4020-5-9AY thru 18AY
3/8	HT4020-6-13A thru 21A <input type="text" value="2"/>	HT4020-6-13AX thru 21AX	HT4020-6-13AY thru 21AY
7/16	HT4020-7-11A thru 25A <input type="text" value="2"/>	HT4020-7-11AX thru 25AX	HT4020-7-11AY thru 25AY
1/2	HT4020-8-8A thru 24A <input type="text" value="2"/>	HT4020-8-8AX thru 24AX	HT4020-8-8AY thru 24AY
NOTES <input type="text" value="1"/> 6AL-4V Titanium <input type="text" value="2"/> PH13-8MO CRES <input type="text" value="3"/> Requires engineering approval for nonmagnetic applications. <input type="text" value="4"/> Requires engineering approval if bolt engages gang channel or platenut. New nut/spacer installation may be required if oversize bolt shank interferes with nut counterbore. <input type="text" value="5"/> If nonthreaded part of bolt extends through structure, install washer(s) between collar and structure. Adjust washer thickness in increments of 0.016 to provide minimum overlap of thread. Use AN960JD washers with aluminum collars and AN960C washers with CRES collars. Inside dia. of added washer(s) to be reamed to oversize hole dia. plus 0.015, see tables 28, 29 and 30. Corrosion and dissimilar metal protection of washer(s) shall be same as requirements of collar.			

Table 23. Hex Shear Head (Short Thread) Bolts

Std Dia	Part Number	First <input type="text" value="4"/> Oversize <input type="text" value="5"/> <input type="text" value="6"/>	Second <input type="text" value="4"/> Oversize <input type="text" value="5"/> <input type="text" value="6"/>
3/16	NAS653V4 thru 11 <input type="text" value="1"/>	MB88-3-4 thru 11 <input type="text" value="2"/>	MB89-3-4 thru 11 <input type="text" value="2"/>
1/4	NAS654V4 thru 14 <input type="text" value="1"/>	MB88-4-4 thru 14 <input type="text" value="2"/>	MB89-4-4 thru 14 <input type="text" value="2"/>
5/16	NAS655V4 thru 15 <input type="text" value="1"/>	MB88-5-4 thru 15 <input type="text" value="2"/>	MB89-5-4 thru 15 <input type="text" value="2"/>
3/8	NAS656V3 thru 16 <input type="text" value="1"/>	MB88-6-3 thru 16 <input type="text" value="2"/>	MB89-6-3 thru 16 <input type="text" value="2"/>
7/16	NAS657V3 thru 18 <input type="text" value="1"/>	MB88-7-3 thru 18 <input type="text" value="2"/>	MB89-7-3 thru 18 <input type="text" value="2"/>
1/2	NAS658V3 thru 20 <input type="text" value="1"/>	MB88-8-3 thru 20 <input type="text" value="2"/>	MB89-8-3 thru 20 <input type="text" value="2"/>
3/16	NAS6303U4 thru 10 <input type="text" value="3"/>	NAS6703U4X thru 10X <input type="text" value="3"/>	NAS6703U4Y thru 10Y <input type="text" value="3"/>

Table 23. Hex Shear Head (Short Thread) Bolts (Continued)

Std Dia	Part Number	First Oversize <input type="text" value="4"/> <input type="text" value="5"/> <input type="text" value="6"/>	Second Oversize <input type="text" value="4"/> <input type="text" value="5"/> <input type="text" value="6"/>
1/4	NAS6304U2 thru 12 <input type="text" value="3"/>	NAS6704U2X thru 12X <input type="text" value="3"/>	NAS6704U2Y thru 12Y <input type="text" value="3"/>
5/16	NAS6305U4 thru 17 <input type="text" value="3"/>	NAS6705U4X thru 17X <input type="text" value="3"/>	NAS6705U4Y thru 17Y <input type="text" value="3"/>
3/8	NAS6306U6 thru 20 <input type="text" value="3"/>	NAS6706U6X thru 20X <input type="text" value="3"/>	NAS6706U6Y thru 20Y <input type="text" value="3"/>
7/16	NAS6307U6 thru 20 <input type="text" value="3"/>	NAS6707U6X thru 20X <input type="text" value="3"/>	NAS6707U6Y thru 20Y <input type="text" value="3"/>
1/2	NAS6308U6 thru 20 <input type="text" value="3"/>	NAS6708U6X thru 20X <input type="text" value="3"/>	NAS6708U6Y thru 20Y <input type="text" value="3"/>
3/16	—	MB88-3-4 thru 20 <input type="text" value="2"/>	MB89-3-4 thru 20 <input type="text" value="2"/>
1/4	—	MB88-4-6 thru 20 <input type="text" value="2"/>	MB89-4-6 thru 20 <input type="text" value="2"/>
5/16	—	MB88-5-4 thru 20 <input type="text" value="2"/>	MB89-5-4 thru 20 <input type="text" value="2"/>
3/8	—	MB88-6-4 thru 20 <input type="text" value="2"/>	MB89-6-4 thru 20 <input type="text" value="2"/>
7/16	—	MB88-7-4 thru 20 <input type="text" value="2"/>	MB89-7-4 thru 20 <input type="text" value="2"/>
1/2	—	MB88-8-3 thru 20 <input type="text" value="2"/>	MB89-8-3 thru 20 <input type="text" value="2"/>

NOTES

- 6AL-4V Titanium.
- PH13-8MO CRES.
- A286 Heat Resistant Steel
- Requires engineering approval for nonmagnetic applications.
- Requires engineering approval if bolt engages gang channel or platenut. New nut/spacer installation may be required if oversize bolt shank interferes with nut counterbore.
- If nonthreaded part of bolt extends through structure, install washer(s) between collar and structure. Adjust washer thickness in increments of 0.016 to provide minimum overlap of thread. Use AN960JD washers with aluminum collars and AN960C washers with CRES collars. Inside dia. of added washer(s) to be reamed to oversize hole dia. plus 0.015, see tables 28, 29 and 30. Corrosion and dissimilar metal protection of washer(s) shall be same as requirements of collar.

Table 24. Hex Shear Head (Long Thread) Bolts

Std Dia	Part Number <input type="text" value="1"/>	First Oversize <input type="text" value="2"/> <input type="text" value="6"/>	Second Oversize <input type="text" value="2"/> <input type="text" value="6"/>
3/16	NAS673V1 thru 50	MB88-3-1 thru 50 <input type="text" value="4"/> <input type="text" value="5"/>	MB89-3-1 thru 50 <input type="text" value="4"/> <input type="text" value="5"/>

Table 24. Hex Shear Head (Long Thread) Bolts (Continued)

Std Dia	Part Number <input type="text" value="1"/>	First Oversize <input type="text" value="2"/> <input type="text" value="6"/>	Second Oversize <input type="text" value="2"/> <input type="text" value="6"/>
1/4	NAS674V2 thru 23	MB88-4-2 thru 23 <input type="text" value="4"/> <input type="text" value="5"/>	MB89-4-2 thru 23 <input type="text" value="4"/> <input type="text" value="5"/>
5/16	NAS675V3 thru 6 NAS675V42 NAS675V70D NAS675V72D NAS675V74D NAS675V103D	MB88-5-3 thru 6 <input type="text" value="4"/> <input type="text" value="5"/> MB88-5-42 <input type="text" value="4"/> <input type="text" value="5"/> MB88-5-70D <input type="text" value="4"/> <input type="text" value="5"/> MB88-5-72D <input type="text" value="4"/> <input type="text" value="5"/> MB88-5-74D <input type="text" value="4"/> <input type="text" value="5"/> MB88-5-103D <input type="text" value="4"/> <input type="text" value="5"/> <input type="text" value="5"/>	MB89-5-3 thru 6 <input type="text" value="4"/> <input type="text" value="5"/> MB89-5-42 <input type="text" value="4"/> <input type="text" value="5"/> MB89-5-70D <input type="text" value="4"/> <input type="text" value="5"/> MB89-5-72D <input type="text" value="4"/> <input type="text" value="5"/> MB89-5-74D <input type="text" value="4"/> <input type="text" value="5"/> MB89-5-103D <input type="text" value="4"/> <input type="text" value="5"/> <input type="text" value="5"/>
3/8	NAS676V14 NAS676V40H NAS676V20D	MB88-6-14 <input type="text" value="4"/> <input type="text" value="5"/> MB88-6-40H <input type="text" value="4"/> <input type="text" value="5"/> MB88-6-20D <input type="text" value="4"/> <input type="text" value="5"/>	MB89-6-14 <input type="text" value="4"/> <input type="text" value="5"/> MB89-6-40H <input type="text" value="4"/> <input type="text" value="5"/> MB89-6-20D <input type="text" value="4"/> <input type="text" value="5"/>
7/16	NAS677V40H	MB88-7-40H <input type="text" value="4"/> <input type="text" value="5"/>	MB89-7-40H <input type="text" value="4"/> <input type="text" value="5"/>
1/2	NAS678V8 thru 24	MB88-8-8 thru 24	MB89-8-8 thru 24
3/16	NAS6703U4 thru 10 <input type="text" value="3"/>	NAS6703U4X thru 10X <input type="text" value="3"/> <input type="text" value="5"/>	NAS6703U4Y thru 10Y <input type="text" value="3"/> <input type="text" value="5"/>
1/4	NAS6704U2 thru 12 <input type="text" value="3"/>	NAS6704U2X thru 12X <input type="text" value="3"/> <input type="text" value="5"/>	NAS6704U2Y thru 12Y <input type="text" value="3"/> <input type="text" value="5"/>
5/16	NAS6705U4 thru 17 <input type="text" value="3"/>	NAS6705U4X thru 17X <input type="text" value="3"/> <input type="text" value="5"/>	NAS6705U4Y thru 17Y <input type="text" value="3"/> <input type="text" value="5"/>
3/8	NAS6706U6 thru 20 <input type="text" value="3"/>	NAS6706U6X thru 20X <input type="text" value="3"/> <input type="text" value="5"/>	NAS6706U6Y thru 20Y <input type="text" value="3"/> <input type="text" value="5"/>
7/16	NAS6707U6 thru 20 <input type="text" value="3"/>	NAS6707U6X thru 20X <input type="text" value="3"/> <input type="text" value="5"/>	NAS6707U6Y thru 20Y <input type="text" value="3"/> <input type="text" value="5"/>
1/2	NAS6708U6 thru 20 <input type="text" value="3"/>	NAS6708U6X thru 20X <input type="text" value="3"/> <input type="text" value="5"/>	NAS6708U6Y thru 20Y <input type="text" value="3"/> <input type="text" value="5"/>
3/16	—	MB88-3-4 thru 20 <input type="text" value="2"/> <input type="text" value="5"/>	MB89-3-4 thru 20 <input type="text" value="2"/> <input type="text" value="5"/>
1/4	—	MB88-4-6 thru 20 <input type="text" value="2"/> <input type="text" value="5"/>	MB89-4-6 thru 20 <input type="text" value="2"/> <input type="text" value="5"/>
5/16	—	MB88-5-4 thru 20 <input type="text" value="2"/> <input type="text" value="5"/>	MB89-5-5 thru 20 <input type="text" value="2"/> <input type="text" value="5"/>
3/8	—	MB88-6-4 thru 20 <input type="text" value="2"/> <input type="text" value="5"/>	MB89-6-4 thru 20 <input type="text" value="2"/> <input type="text" value="5"/>

Table 24. Hex Shear Head (Long Thread) Bolts (Continued)

Std Dia	Part Number <input type="text" value="1"/>	First Oversize <input type="text" value="2"/> <input type="text" value="6"/>	Second Oversize <input type="text" value="2"/> <input type="text" value="6"/>
7/16	—	MB88-7-4 thru 20 <input type="text" value="2"/> <input type="text" value="5"/>	MB89-7-4 thru 20 <input type="text" value="2"/> <input type="text" value="5"/>
1/2	—	MB88-8-4 thru 20 <input type="text" value="2"/> <input type="text" value="5"/>	MB89-8-3 thru <input type="text" value="2"/> <input type="text" value="5"/>
NOTES <input type="text" value="1"/> 6AL-4V Titanium. <input type="text" value="2"/> PH13-8MO CRES. <input type="text" value="3"/> A286 Heat Resistant Steel. <input type="text" value="4"/> Requires engineering approval for nonmagnetic applications. <input type="text" value="5"/> Requires engineering approval if bolt engages gang channel or plate nut. New nut/spacer installation may be required if oversize bolt shank interferes with nut counterbore. <input type="text" value="6"/> If nonthreaded part of bolt extends through structure, install washer(s) between collar and structure. Adjust washer thickness in increments of 0.016 to provide minimum overlap of thread. Use AN960JD washers with aluminum collars and AN960C washers with CRES collars. Inside dia. of added washer(s) to be reamed to oversize hole dia. plus 0.015, see tables 28, 29 and 30. Corrosion and dissimilar metal protection of washer(s) shall be same as requirements of collar.			

Table 25. Spline Drive Bolts

Std Dia	Part Number <input type="text" value="1"/>	First Oversize <input type="text" value="1"/> <input type="text" value="2"/>	Second Oversize <input type="text" value="1"/> <input type="text" value="2"/>
3/16	VS3191-3-D20	VS3191-3-20X	VS3191-3-20Y
1/4	VS3191-4-6 thru 16	VS3191-4-6X thru 16X	VS3191-4-6Y thru 16Y
5/16	VS3191-5-7 thru 15	VS3191-5-7X thru 15X	VS3191-5-7Y thru 15Y
3/8	VS3191-6-24	VS3191-6-24X	VS3191-6-24Y
7/16	VS3191-7-3 thru 15	VS3191-7-3X thru 15X	VS3191-7-3Y thru 15Y
1/2	VS3191-8-3 thru 14	VS3191-8-3X thru 14X	VS3191-8-3Y thru 14Y
9/16	VS3191-9-3 thru 13	VS3191-9-3X thru 13X	VS3191-9-3Y thru 13Y
5/8	VS3191-10-3 thru 12	VS3191-10-3X thru 12X	VS3191-10-3Y thru 12Y
3/16	—	MB88-3-4 thru 20	MB89-3-4 thru 20
1/4	—	MB88-4-3 thru 18	MB89-4-3 thru 18
5/16	—	MB88-5-3 thru 18	MB89-5-3 thru 18
3/8	—	MB88-6-3 thru 20	MB89-6-3 thru 20

Table 25. Spline Drive Bolts (Continued)

Std Dia	Part Number ◀ 1	First Oversize ◀ 1 ◀ 2	Second Oversize ◀ 1 ◀ 2
7/16	—	MB88-7-3 thru 20	MB89-7-3 thru 20
1/2	—	MB88-8-3 thru 18	MB89-8-3 thru 18
9/16	—	MB88-9-3 thru 16	MB89-9-3 thru 16
5/8	—	MB88-10-3 thru 18	MB89-10-3 thru 18

NOTES

◀ 1 ▶ PH13-8MO CRES.

◀ 2 ▶ If nonthreaded part of bolt extends through structure, install washer(s) between collar and structure. Adjust washer thickness in increments of 0.016 to provide minimum overlap of thread. Use AN960JD washers with aluminum collars and AN960C washers with CRES collars. Inside dia. of added washer(s) to be reamed to oversize hole dia. plus 0.015, see tables 28, 29 and 30. Corrosion and dissimilar metal protection of washer(s) shall be same as requirements of collar.

Table 26. Spline Drive (Short Thread) Bolts

Std Dia	Part Number ◀ 1	First Oversize ◀ 1 ◀ 2	Second Oversize ◀ 1 ◀ 2
3/16	VS3174-3D7 thru D11 VS3174-3D22	VS3191-3D7X thru D11X VS3191-3D22X	VS3191-3D7Y thru D11Y VS3191-3D22Y
1/4	VS3174-4D13 VS3174-4D22 VS3174-4D23 VS3174-4D33 VS3174-4D34 VS3174-4D77	VS3191-4D13X VS3191-4D22X VS3191-4D23X VS3191-4D33X VS3191-4D34X VS3191-4D77X	VS3191-4D13Y VS3191-4D22Y VS3191-4D23Y VS3191-4D33Y VS3191-4D34Y VS3191-4D77Y
5/16	VS3174-5D15 VS3174-5D20 VS3174-5D33 VS3174-5D64	VS3191-5D15X VS3191-5D20X VS3191-5D33X VS3191-5D64X	VS3191-5D15Y VS3191-5D20Y VS3191-5D33Y VS3191-5D64Y
3/8	VS3174-6D15 thru D23 VS3174-6D33 thru D36	VS3191-6D15X thru D23X VS3191-6D33X thru D36X	VS3191-6D15Y thru D23Y VS3191-6D33Y thru D36Y
7/16	VS3174-7D25 VS3174-7H59	VS3191-7D25X VS3191-7H59X	VS3191-7D25Y VS3191-7H59Y
1/2	VS3174-8D32 VS3174-8D66	VS3191-8D32X VS3191-8D66X	VS3191-8D32Y VS3191-8D66Y
9/16	VS3174-9-4 thru 24	VS3191-9-4 thru 24	VS3191-9-4 thru 24

Table 26. Spline Drive (Short Thread) Bolts (Continued)

Std Dia	Part Number <input type="text" value="1"/>	First Oversize <input type="text" value="1"/> <input type="text" value="2"/>	Second Oversize <input type="text" value="1"/> <input type="text" value="2"/>
5/8	VS3174-10D30 thru D33 VS3174-10D68	VS3191-10D30X thru D33X VS3191-10D68X	VS3191-10D30Y thru D33Y VS3191-10D68Y
3/16	—	MB88-3-4 thru 20	MB89-3-4 thru 20
1/4	—	MB88-4-3 thru 18	MB89-4-3 thru 20
5/16	—	MB88-5-3 thru 17	MB89-5-3 thru 17
3/8	—	MB88-6-3 thru 16	MB89-6-3 thru 16
7/16	—	MB88-7-3 thru 20	MB89-7-3 thru 20
1/2	—	MB88-8-3 thru 18	MB89-8-3 thru 18
9/16	—	MB88-9-3 thru 18	MB89-9-3 thru 18
5/8	—	MB88-10-3 thru 18	MB89-10-3 thru 18

NOTES

PH13-8MO CRES.

If nonthreaded part of bolt extends through structure, install washer(s) between collar and structure. Adjust washer thickness in increments of 0.016 to provide minimum overlap of thread. Use AN960JD washers with aluminum collars and AN960C washers with CRES collars. Inside dia. of added washer(s) to be reamed to oversize hole dia. plus 0.015, see tables 28, 29 and 30. Corrosion and dissimilar metal protection of washer(s) shall be same as requirements of collar.

Table 27. Spline Drive Flanged Head Bolts

Std Dia	Part Number <input type="text" value="1"/>	First Oversize <input type="text" value="1"/> <input type="text" value="2"/>	Second Oversize <input type="text" value="1"/> <input type="text" value="2"/>
3/16	MB156-3-8 thru 16	MB87-3-8 thru 16	MB87-3-8 thru 16
1/4	MB156-4-7 thru 17 MB156-4-D9 thru D13	MB87-4-7 thru 17 MB87-4-D9 thru D13	MB87-4-7 thru 17 MB87-4-D9 thru D13
5/16	MB156-5-14 thru 20 MB156-5-23 MB156-5-24 MB156-5-28 MB156-5-33 MB156-5D14 thru D16 MB156-5D23 MB156-5D24 MB156-5D33	MB87-5-14 thru 20 MB87-5-23 MB87-5-24 MB87-5-28 MB87-5-33 MB87-5D14 thru D16 MB87-5D23 MB87-5D24 MB87-5D33	MB87-5-14 thru 20 MB87-5-23 MB87-5-24 MB87-5-28 MB87-5-33 MB87-5D14 thru D16 VS3190-5D23 VS3190-5D24 VS3190-5D33

Table 27. Spline Drive Flanged Head Bolts (Continued)

Std Dia	Part Number <input type="text" value="1"/>	First Oversize <input type="text" value="1"/> <input type="text" value="2"/>	Second Oversize <input type="text" value="1"/> <input type="text" value="2"/>
3/8	MB156-6-16 MB156-6-44 MB156-6H14F	MB87-6-16 MB87-6-44 MB87-6H14F	MB87-6-16 MB87-6-44 MB87-6H14F
7/16	MB156-7-84 MB156-7H16F	MB87-7-84 MB87-7H16F	MB87-84 MB87-7H16F
1/2	MB156-8-21 MB156-8-61 MB156-8-82	MB87-8-21 MB87-8-61 MB87-8-82	MB87-8-21 MB87-8-61 MB87-8-82
9/16	MB156-9-4 thru 12	MB87-9-4 thru 12	MB87-9-4 thru 12
5/8	MB156-10-4 thru 12	MB87-10-4 thru 12	MB87-10-4 thru 12
3/4	MB156-11-4 thru 16	MB87-11-4 thru 16	MB87-11-4 thru 16

NOTES PH13-8MO CRES.

If nonthreaded part of bolt extends through structure, install washer(s) between collar and structure. Adjust washer thickness in increments of 0.016 to provide minimum overlap of thread. Use AN960JD washers with aluminum collars and AN960C washers with CRES collars. Inside dia. of added washer(s) to be reamed to oversize hole dia. plus 0.015, see tables 28, 29 and 30. Corrosion and dissimilar metal protection of washer(s) shall be same as requirements of collar.

9. **HOLE SIZES FOR OVERSIZE FASTENERS.** Refer to tables 28 through 32.

Table 28. Close Tolerance For Bolts and Pins

Std Dia	Interference 0.0010 To 0.0045 Std Fastener First Oversize Second Oversize	Interference 0.0005 To 0.0035 Std Fastener First Oversize Second Oversize
1/8	—	—
5/32 (#8)	0.1600 +0.0025 — -0.0000 0.185	0.1600 +0.0025 — -0.0000 0.186
3/16 (#10)	0.185 +0.0030 0.1981 -0.0000 0.2137	0.186 +0.0025 0.1991 -0.0000 0.2147





Table 28. Close Tolerance For Bolts and Pins (Continued)

Std Dia	Interference 0.0010 To 0.0045 Std Fastener First Oversize Second Oversize		Interference 0.0005 To 0.0035 Std Fastener First Oversize Second Oversize	
1/4	0.245 0.2606 0.2762	+0.0030 -0.0000	0.246 0.2616 0.2772	+0.0025 -0.0000
5/16	0.3075 0.3231 0.3387	+0.0030 -0.0000	0.3085 0.3241 0.3397	+0.0025 -0.0000
3/8	0.3700 0.3856 0.4012	+0.0030 -0.0000	0.371 0.3866 0.4022	+0.0025 -0.0000
7/16	0.4325 0.4481 0.4637	+0.0030 -0.0000	0.4335 0.4491 0.4647	+0.0025 -0.0000
1/2	—	—	—	—
9/16	—	—	—	—
5/8	—	—	—	—
3/4	—	—	—	—
NOTES				
See table 30 for close tolerance bolts and pins for graphite epoxy only.				

Table 29. Class 1, Class 2, Class 3, and Class D Tolerance For Bolts and Pins

Std. Dia.	Class 1 Std. Fastener First Oversize Second Oversize		Class 2 Std. Fastener First Oversize Second Oversize		Class 3 Std. Fastener First Oversize Second Oversize		Class D Std. Fastener First Oversize Second Oversize	
1/8	0.1245 — 0.1635	+0.0015 -0.0007	0.1245 — 0.1635	+0.0025 -0.0000	0.127 — 0.166	+0.006 -0.000		
5/32	0.1635 — 0.1895	+0.0015 -0.0007	0.1635 — 0.1895	+0.0025 -0.0000	0.166 — 0.191	+0.006 -0.000	0.169 — 0.196	+0.006 -0.000

Table 29. Class 1, Class 2, Class 3, and Class D Tolerance For Bolts and Pins
(Continued)

Std. Dia.	Class 1 Std. Fastener First Oversize Second Oversize	Class 2 Std. Fastener First Oversize Second Oversize	Class 3 Std. Fastener First Oversize Second Oversize	Class D Std. Fastener First Oversize Second Oversize
3/16	0.1895 +0.0015 0.2026 -0.0007 0.2182	0.1895 +0.0025 0.2026 -0.0000 0.2182	0.191 +0.006 0.204 -0.000 0.220	0.195 +0.007 0.208 -0.000 0.224
1/4	0.2495 +0.0015 0.2651 -0.0007 0.2807	0.2495 +0.0025 0.2651 -0.0000 0.2807 	0.250 +0.006 0.265 -0.000 0.281	0.255 +0.007 0.270 -0.000 0.286
5/16	0.3120 +0.0015 0.3276 -0.0007 0.3432	0.3120 +0.0020 0.3276 -0.0000 0.3432 	0.312 +0.007 0.327 -0.000 0.343	0.322 +0.007 0.337 -0.000 0.353
3/8	0.3745 +0.0015 0.3901 -0.0007 0.4057	0.3745 +0.0020 0.3901 -0.0000 0.4057 	0.375 +0.007 0.390 -0.000 0.406	0.385 +0.008 0.400 -0.000 0.416
7/16	—	0.4370 +0.0020 0.4526 -0.0000 0.4682 	0.4375 +0.007 0.453 -0.000 0.469	0.452 +0.008 0.467 -0.000 0.483
1/2	—	0.4995 +0.0020 0.5151 -0.0000 0.5307	0.500 +0.007 0.515 -0.000 0.531	0.515 +0.008 0.531 -0.000 0.546
9/16	—	0.5620 +0.0020 0.5776 -0.0000 0.5932	0.562 +0.009 0.578 -0.000 0.593	0.578 +0.009 0.594 -0.001 0.609
5/8	—	0.6245 +0.0020 0.6401 -0.0000 0.6557	0.625 +0.008 0.641 -0.001 0.656	0.640 +0.009 0.656 -0.001 0.671
3/4	—	0.7495 +0.0020 0.7651 -0.0000 0.7807	0.750 +0.008 0.7656 -0.001 0.781	0.765 +0.010 0.781 -0.001 0.796

NOTES


 See table for 30 close tolerance bolts and pins for graphite epoxy only.

Table 30. Hole Sizes For Close Tolerance Bolts and Pins in Graphite Epoxy

Std. Dia.	(Class II G) Upper Surface Wing Skin Std. Fastener First Oversize Second Oversize	(Class II) Lower Surface Torque Box Skin Std. Fastener First Oversize Second Oversize	(Class I) Lower Surface Trailing Edge Skin Std. Fastener First Oversize Second Oversize	(Class G) Vertical Stabilizer Horizontal Stabilator Std. Fastener First Oversize Second Oversize
5/32	0.164 +0.003 — -0.000 —	0.1635 +0.0025 — -0.0000 0.1895	0.1635 +0.0015 — -0.0007 0.1895	0.1640 +0.004 — -0.000 0.190
3/16	0.190 +0.003 0.2031 -0.000 0.2187	0.1895 +0.0025 0.2026 -0.0000 0.2182	0.1895 +0.0015 0.2026 -0.0007 0.2182	0.190 +0.004 0.2031 -0.000 0.2187
1/4	0.250 +0.003 0.2656 -0.000 0.2812	0.2495 +0.0025 0.2651 -0.0000 0.2807	0.2495 +0.0015 0.2651 -0.0007 0.2807	0.250 +0.004 0.2656 -0.000 0.2812
5/16	0.3125 +0.003 0.3281 -0.000 0.3437	0.3120 +0.002 0.3276 -0.000 0.3432	0.3120 +0.0015 0.3276 -0.0000 0.3432	0.3125 +0.004 0.3281 -0.000 0.3437
3/8	0.3750 +0.003 0.3906 -0.000 0.4062	0.3745 +0.002 0.3901 -0.000 0.4057	0.3745 +0.0015 0.3901 -0.0007 0.4057	0.3750 +0.004 0.3906 -0.000 0.4062
7/16	0.4375 +0.003 0.4531 -0.000 0.4687	0.4370 +0.002 0.4526 -0.000 0.4682	0.4370 +0.0015 0.4526 -0.0007 0.4682	0.4375 +0.004 0.4531 -0.000 0.4687
1/2	0.5000 +0.003 0.5156 -0.000 0.5312	0.4995 +0.002 0.5151 -0.000 0.5307	0.4995 +0.0015 0.5151 -0.0007 0.5307	0.5000 +0.004 0.5156 -0.000 0.5312

Table 31. Hole Sizes For Oversize Blind Fasteners (Jo-Bolts)

Std. Dia.	Std. Hole Size	First Oversize	Second Oversize
5/32	+0.003 0.1645 -0.000	+0.0030 0.180 -0.0000	+0.0030 0.1990 -0.0000
3/16	+0.003 0.199 -0.000	+0.0030 0.2150 -0.0000	—
1/4	+0.003 0.260 -0.000	+0.0030 0.2760 -0.0000	—

Table 31. Hole Sizes For Oversize Blind Fasteners (Jo-Bolts) (Continued)

Std. Dia.	Std. Hole Size	First Oversize	Second Oversize
5/16	+0.003 0.312 -0.000	+0.0030 0.3275 -0.0000	—
3/8	+0.003 0.375 -0.000	+0.0030 0.3905 -0.0000	—

Table 32. Hole Sizes For Oversize Fasteners In Stress - Coined Holes

Std Dia.	Class II Fastener	O.S. Cond.	Pre-Coined Hole Dia	Final Hole Dia	Expanding Pin Part Number
1/4	0.2495 +0.0025 -0.0000	1/64	0.262 to 0.264	0.2651 +0.0025 -0.0000	C652-74841 0.2680
		1/32	0.278 to 0.280	0.2807 +0.0025 -0.0000	C652-74841 0.2840
5/16	0.3120 +0.0020 -0.0000	1/64	0.325 to 0.327	0.3276 +0.0020 -0.0000	C652-74841 0.3315
		1/32	0.340 to 0.342	0.3432 +0.0020 -0.0000	C652-74841 0.3470

Table 33. Minimum Allowable Protrusion of Bolts Through Self-Locking Nuts

Standard Bolt Size	Minimum Allowable Protrusion Through Nut
1/4	0.060
5/16 or 3/8	0.070
7/16 or 1/2	0.080
9/16 or 5/8	0.090
3/4	0.120
7/8	0.140
1, 1-1/8, or 1-1/4	0.170

ORGANIZATIONAL MAINTENANCE

STRUCTURE REPAIR

SHOP PRACTICES

DRILLING AND MACHINING COMPOSITES

Reference Material

None

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Record of Applicable Technical Directives

None

1. INTRODUCTION.

2. This work package defines procedures for working graphite epoxy, graphite epoxy in combination with aluminum or titanium, graphite epoxy honeycomb sandwich assemblies, and Aramid laminate.

3. GENERAL INFORMATION.

a. Use carbide, steel, or diamond tools for drilling holes in graphite epoxy composites.

b. Use cutting fluid for drilling.

- c. Do not use cutting fluid when drilling or reaming operations enter honeycomb core having skins bonded on both sides.
- d. Use aluminum backup for drilling operations. Backup must cover tool exit surface completely and be held firmly against work area.
- e. When using diamond tools, inspect cutting surface before use. Diamond plated tools showing bare metal in cutting areas shall be replaced. Remove resin or other contaminants from tools with a tool dresser.
- f. When using carbide tools, inspect and replace when nicks, chips, or other cutting surface defects are found.
- g. Depot engineering approval is required for any composite operation not covered in this work package.



Do not mark composite with any method that indents or deforms surface.

Use MIL-P-83953 TY1CLB aircraft yellow marking pencil to mark bare and coated composite surfaces.

- h. Use rubber stamps, tags, or adhesive decals to mark composite parts.
- i. After drilling or machining operations, composite assemblies shall be cleaned.
- j. Excess cutting fluid shall be removed from all assemblies upon completion of work or at end of each shift.

4. SAFETY PRECAUTIONS.

- a. It is recommended, the person doing drilling wear a respirator even when cutting fluid is used.
- b. When drilling without cutting fluid, dust must be collected in a vacuum system and operator must use respirator.
- c. Always wear eye protection when drilling, reaming, or countersinking.

5. REQUIREMENTS.

- a. Locate and drill holes as specified.

NOTE

Slight splintering around hole to be countersunk is allowed provided there is no splintering after countersinking.

- b. No visually detected splintering or delaminations of drilled surfaces are allowed, see figure 1.

- c. Delaminations or whitening/starring around holes may be repaired without engineering approval if they do not extend into part lesser of 10 percent hole diameter or 0.040 inch.

- d. Cutting fluid shall not be used when drilling or reaming operations go into honeycomb core that has adhesive bonded skins on both sides.

- e. Cutting fluid shall be used for drilling, reaming, and countersinking graphite epoxy composites.

- f. Holes through aramid laminate may be drilled dry or with water coolant.

NOTE

Parts fabricated with a peel ply have the words peel ply rubber stamped on them. Do not remove peel ply from surfaces which are to be subsequently structurally bonded. Work these areas with peel ply in place.

- g. Splintering is minimized by allowing peel ply to remain on assemblies during hole preparation. Peel ply is locally removed after hole preparation when:

- (1) Protruding head fasteners are to be installed.

- (2) Solid rivets are to be installed.

- (3) Splintering around hole or countersink is suspected.

- h. Tool life when drilling composites is limited. Monitor cutting edges and cutting action during drilling operation. Replace drill when any drill chatter, chipped cutting edges, overheated material, worn cutting edges, excessive splintering, or other evidence of bad cutting action occurs.

i. After drilling operations, composites shall be cleaned.

j. Holes in graphite epoxy shall be drilled using procedures and tools specified in procedures 1 through 3, 6, 7, 10, and 11. Refer to paragraph 6.

k. The 0.070 inch diameter holes used for kevlar yarn ties are allowed to have delamination(s) completely around circumference, provided delamination(s) do not extend into part more than one hole diameter.

6. GRAPHITE EPOXY LAMINATE.

Support Equipment Required

NOTE

Alternate item type designations or part numbers are listed in parentheses.

Part Number or Type Designation	Nomenclature
—	Air Feed Unit
No. 11 DPV-15DA-450/1250	Variable Speed Drill Motor
TD731B	Coolant Chuck and Dual Hydraulic Feed Control Units
TFIM25.0235 (TFIM25.02340)	Carbide Twist Drill
TFIM25.121	Carbide Reamer
—	Drill Motor, 2,000 RPM Max.
—	Drill Motor, 250 RPM Max.
—	High Speed Steel (HSS) Reamers
PSMT1628	Flat Flute Drill, Extra Short
TFIM25.0254	Flat Flute Drill, Short
—	50° Included Angle Countersink
—	Adjustable stop Countersink
TD562R2-2	Diamond Plated Countersink
—	Vacuum System, For Picking up Composite Dust
GGG-M-125/6	Respirator With Cartridge

Support Equipment Required (Continued)

NOTE

Alternate item type designations or part numbers are listed in parentheses.

Part Number or Type Designation	Nomenclature
TFIM25.0253	Flat Flute Drill
—	Drill Motor, 500 RPM Max.
101725R thru 101083R	Body, Everede Tool Co.
No's 30492R, 30493R, 30496R, 30497R	Cuttler, Everede Tool Co.
TD90K1	Diamond Core Drill
TD729E	Diamond Plated Blade
TD 729D	Diamond Impregnated Blade
TSBAC-1,2,3, or 4	Abrasive Plated Band Saw Blade
TFIM 25.53 or Equal	Solid Carbide Fluted End Mills
TR121-127-2477- 8TD or Equal	Carbide Inserted Blade End Mills
TD595T-8	Diamond Router Bit
TFIM25.000099	Carbide Router Bit, Diamond Shape Chisel Cut
74D110172-1001	Tool Set, Structural Repair, Composite Materials

Materials Required

Specification or Part Number	Nomenclature
ISOPAR M	Cutting Fluid
TEMPILSTIK275DEGF	Temperature Indicating Material
A-A-1047, GRIT 80-9X11 through 320-9X11	Abrasive Paper

7. **Hole Preparation.** All drilling, reaming, and countersinking of graphite epoxy composites shall be performed in strict compliance with applicable procedures listed in table 1.

Table 1. Hole Preparation Procedure Selection

Skin Material	Substructure Materials							
	Aluminum		Titanium		Gr. Epoxy ◀ 1		None	
	Para	Proc	Para	Proc	Para	Proc	Para	Proc
Graphite Epoxy ◀ 2	9 10	2 or 3	9 10	2 or 3	8 11	1 ◀ 3 or 6	8 11	1 ◀ 3 or 6
Graphite Epoxy With Titanium Splice Plate	12	7	—		—		—	

NOTES

- ◀ 1 ▶ Refer to paragraph 12, procedure 7 for drilling holes in graphite epoxy for nutplate attach rivets.
- ◀ 2 ▶ Refer to paragraph 13, procedure 10 for countersinking holes in graphite epoxy for flush head fasteners and paragraph 14, procedure 11 for edge breaking holes in graphite epoxy for protruding head fasteners.
- ◀ 3 ▶ This procedure used for core sample verification.

8. **Procedure 1.** See figure 2.

WARNING

Wear eye protection during all drilling and machining operations.

using an air feed drill motor and TD731B coolant chuck, operating at specifications of table 2. If required, countersink for flush head fasteners per paragraph 13, procedure 10 or break edge of graphite epoxy for protruding head fasteners per paragraph 14, procedure 11.

a. Drill through graphite epoxy into aluminum backup material with a TD90K1 diamond core drill,

Table 2. Equipment Parameters For Procedure 1

Hole Diameter (Inch)	Feed Pressure (PSI) ◀ 1	Speed (RPM)	Coolant Pressure (PSI) ◀ 2
5/32	10 Thru 18	1250	800
3/16	10 Thru 18	1250	800
1/4	12 Thru 20	1250	800
5/16	15 Thru 22	1250	400
3/8	15 Thru 22	1250	400

NOTES

- ◀ 1 ▶ Adjust hydraulic feed control so feed rate does not exceed 0.25 inch/minute in air.
- ◀ 2 ▶ Static pressure at pump.

Table 2. Equipment Parameters For Procedure 1 (Continued)

Hole Diameter (Inch)	Feed Pressure (PSI) ◀ 1	Speed (RPM)	Coolant Pressure (PSI) ◀ 2
3. Equipment Air feed unit No. 11 DPV-15DA-450/1250 variable speed drill motor. TD731B coolant chuck and dual hydraulic feed control units or equal.			

9. **Procedure 2.** See figure 2.

a. Drill through graphite epoxy and aluminum/titanium with carbide twist drills TFIM25.0235 or TFIM25.02340. Use positive feed or air feed drill motors operating at speeds and feed rates listed in table 3.

b. If reaming is required, ream hole to final size using TFIM25.121 carbide reamers. Use positive feed or air feed drill motors operating at speeds and feed rates listed in table 3.

Table 3. Equipment Parameters For Procedure 2

Substructure Materials	Hole Dia. (Inch)	Drilling and Reaming ◀ 2		
		Max. Speed (RPM)		Feed Rate Sec/Inch ◀ 1
		With Coolant	Dry	
Aluminum	5/32	4000	2000	0.002
	3/16	4000	2000	0.002
	1/4	3000	1500	0.002
	5/16	2400	1200	0.002
	3/8	2000	1000	0.002
	7/16	1800	900	0.002
Titanium	5/32	600	200	0.002
	3/16	600	200	0.002
	1/4	450	150	0.002
	5/16	350	120	0.002
	3/8	300	100	0.002
	7/16	265	100	0.002

NOTES

◀ 1 Numbers are recommended feed rates for positive feed drill motors. For air feed motors, adjust hydraulic check valves to get 30 to 45 seconds per inch feed in air. For hand fed drill motors with surge control, Align-A-Drill with hydraulic check valves, and similar equipment, adjust hydraulic check valves to get 10 to 15 seconds per inch feed rate in air with 20 pound feed force.

◀ 2 Hand fed drill motors without surge control may be used to drill holes through woven graphite epoxy parts and metal substructure. Use of appropriate alignment bushings is recommended for holes 0.202 inch diameter and smaller and mandatory for holes 0.203 inch diameter and larger. Drill holes within limitations listed below:

a. Aluminum-graphite epoxy holes 0.202 inch diameter and smaller use 2,000 RPM max drill motor.

Table 3. Equipment Parameters For Procedure 2 (Continued)

Substructure Materials	Hole Dia. (Inch)	Drilling and Reaming ◀ 2		
		Max. Speed (RPM)		Feed Rate Sec/Inch ◀ 1
		With Coolant	Dry	
<p>b. Aluminum-graphite epoxy holes 0.203 inch diameter and larger use 500 RPM max drill motor.</p> <p>c. Titanium-graphite epoxy holes of all sizes use 250 RPM max drill motor.</p> <p>d. Hand fed drilling or reaming of unidirectional graphite epoxy broadgood requires depot engineering disposition.</p> <p>3. Use a flood or low pressure heavy spray mist of cutting fluid for drilling/reaming. Do not use any cutting fluid when hole(s) enter bonded honeycomb structure. Dry drilling/reaming operations are not recommended, but may be used for pilot holes and clean room drilling/reaming operations. When cutting fluid is not used, temperature indicating material with 275°F temperature rating shall be used.</p> <p>4. Paragraph 10, procedure 3 may also be used for producing holes through graphite epoxy and thin aluminum less than 0.150 inch.</p> <p>5. Channel seal groove(s) in aluminum or titanium must be filled so graphite epoxy is firmly supported during drilling/reaming operations.</p> <p>6. For close tolerance holes, it is recommended:</p> <p>a. Use 1/64 undersize drills and ream hole(s) to final size.</p> <p>b. If high speed steel (HSS) reamers are used, a new or resharpened reamer for each hole is required.</p> <p>7. If required, countersink graphite epoxy for flush head fasteners per paragraph 13, procedure 10 or break edge of graphite epoxy for protruding head fasteners per paragraph 14, procedure 11.</p>				

10. **Procedure 3.** See figure 2.

(2) TFIM25.0253 Flat Flute Drills.

a. Drill through graphite epoxy and aluminum using a air feed drill motor operating at speeds and feed rates listed in table 4. Use carbide flat flute drills listed below:

(3) TFIM25.0254 Flat Flute Drills, Short.

(1) PSMT1628 Flat Flute Drills, extra short.

b. If required, ream hole(s) to final size using TFIM25.121 carbide reamers. Use air feed drill motor operating at speeds and feed rates listed in table 4.

Table 4. Equipment Parameters For Procedure 3

Substructure Materials	Hole Dia. (Inch)	Drilling and Reaming 2		
		Max. Speed (RPM)		Feed Rate Sec/Inch 1
		With Coolant	Dry	
Aluminum or Graphite Epoxy	5/32	4000	2000	30 to 45
	3/16	4000	2000	30 to 45
	1/4	3000	1500	30 to 45
	5/16	2400	1200	30 to 45
	3/8	2000	1000	30 to 45
Titanium	5/32	500	200	30 to 45
	3/16	500	200	30 to 45
	1/4	350	150	30 to 45
	5/16	300	120	30 to 45
	3/8	250	100	30 to 45

NOTES

- 1 For air feed motors with surge control, adjust hydraulic check valves to get specified feed in air. For hand fed drill motors with surge control, Align-A-Drill with hydraulic check valves, and similar equipment, adjust hydraulic check valves to get 10 to 15 seconds per inch feed rate in air with a 20 pound feed force.
- 2 Hand fed drill motors without surge control may be used to drill holes through woven graphite epoxy parts and metal substructure. Use of correct alignment bushings is recommended for holes 0.202 inch diameter and smaller and mandatory for holes 0.203 inch diameter and larger. Drill holes within limitations listed below:
- Aluminum-graphite epoxy holes 0.202 inch diameter and smaller use 2,000 RPM max drill motor.
 - Aluminum-graphite epoxy holes 0.203 inch diameter and larger use 500 RPM max drill motor.
 - Titanium-graphite epoxy holes of all sizes use 250 RPM max drill motor.
 - Free hand drilling and reaming of unidirectional graphite epoxy broadgood parts is prohibited.
- 3 For reaming, a maximum of 0.005 inch diameter shall be removed in one reaming pass through graphite epoxy laminate.
- Use a flood or low pressure heavy spray mist of cutting fluid during drilling and reaming operations. Do not use cutting fluid when hole(s) enter bonded honeycomb structure. When cutting fluid is not used, temperature indicating material with 275° F temperature rating shall be used.
 - Use paragraph 9, procedure 2 if aluminum thickness exceeds 0.150 inch or if titanium is in the joint.
 - Channel seal groove in aluminum; it is not required to fill groove to support graphite epoxy to prevent splintering with flat flute drills, however, if reaming is required and hole passes through an unfilled seal groove, only 0.005 inch on diameter, maximum, shall be removed in one reamer pass if hand fed motors with no surge control are used.

Table 4. Equipment Parameters For Procedure 3 (Continued)

Substructure Materials	Hole Dia. (Inch)	Drilling and Reaming ◀ 2		
		Max. Speed (RPM)		Feed Rate Sec/Inch ◀ 1
		With Coolant	Dry	
7. If required, countersink graphite epoxy for flush head fasteners per paragraph 13, procedure 10 or break edge of graphite epoxy for protruding head fasteners per paragraph 14, procedure II.				
8. If high speed steel (HSS) reamers are used, a new or resharpened reamer shall be used for each hole.				

11. **Procedure 6.** See figure 2.

a. Drill through graphite epoxy composite using a air feed drill motor operating at speeds and feed rates listed in table 5. Use carbide flat flute drills listed below:

(1) PSMT1628 Flat Flute Drills, extra short.

(2) TFIM25.0253 Flat Flute Drills.

(3) TFIM25.0254 Flat Flute Drills, short.

b. If required, ream hole(s) to final size using TFIM25.121 carbide reamer in air feed drill motor or hand fed drill motor operating at speeds and feed rates specified in table 5. Back up reamer exit to prevent splintering and delaminations if more than 0.005 inch material is being removed.

Table 5. Equipment Parameters For Procedure 6

Hole Dia. (Inch)	Drilling ◀ 3 and Reaming ◀ 4	
	Speed (RPM)	Feed Rate ◀ 1 ◀ 2
5/32	900 thru 2700	30 thru 45 Sec/In
3/16	900 thru 2700	30 thru 45 Sec/In
1/4	900 thru 2700	30 thru 45 Sec/In
5/16	900 thru 2700	30 thru 45 Sec/In
3/8	900 thru 2700	30 thru 45 Sec/In

NOTES

◀ 1 Adjust hydraulic feed control units to get correct feed rate in air.

Table 5. Equipment Parameters For Procedure 6 (Continued)

Hole Dia. (Inch)	Drilling ◀ 3 and Reaming ◀ 4	
	Speed (RPM)	Feed Rate ◀ 1 ◀ 2
◀ 2	Numbers are recommended feed rates for air feed drill motors with surge control. For hand fed drill motors with surge control, Align-A-Drill with hydraulic check valves, and similar equipment, adjust hydraulic check valves to obtain 10 to 15 seconds per inch feed rate in air with 20 pound feed force.	
◀ 3	Hand fed drill motors without surge control may be used with below listed limitations. Use of correct alignment bushings is recommended for holes 0.202 inch diameter and smaller and mandatory for holes 0.203 inch diameter and larger. a. Reaming - Use 500 RPM max speed drill motor. b. To drill woven graphite epoxy cloth parts use 500 RPM max speed drill motor for holes 0.203 inch diameter and larger and 2000 RPM max speed drill motor for holes 0.202 inch diameter and smaller.	
◀ 4	For reaming, maximum of 0.005 inch diameter shall be removed in one reamer pass through graphite epoxy laminate. Use aluminum backup material where access allows.	

Table 5. Equipment Parameters For Procedure 6 (Continued)

Hole Dia. (Inch)	Drilling ◀ 3 and Reaming ◀ 4	
	Speed (RPM)	Feed Rate ◀ 1 ◀ 2
<p>5. If hand fed drill motors are used for reaming with no backup, only 0.005 inch diameter, maximum, shall be removed in one reamer pass. If high speed steel (HSS) reamers are used, new or resharpened reamer shall be used for each hole.</p> <p>6. Use flood or low pressure heavy spray mist of cutting fluid or water during drilling or reaming operation. Do not use any cutting fluid when hole(s) enter bonded honeycomb structure. When cutting fluid is not used, temperature indicating material with 275°F temperature rating shall be used.</p>		

12. **Procedure 7.** See figure 2.

a. Drill through graphite epoxy and titanium using carbide twist drills TFIM25.0235 or TFIM25.02340. Use positive feed equipment at speeds and feed rates listed in table 6.

b. If required, ream hole(s) to final size using TFIM25.121 carbide reamers. Use positive feed drill motors at speeds and feed rates listed in table 6. Do not ream more than 10 holes before returning carbide reamer for resharpening.

Table 6. Equipment Parameters For Procedure 7

Drilling and Reaming				
Substructure Material	Hole Dia. (Inch)	Speed (RPM)	Feed Rate Sec/Inch ◀ 1	
			Drilling	Reaming
Titanium	3/16	600	0.002	0.006
	1/4	450	0.002	0.006
	5/16	350	0.002	0.006
	3/8	300	0.002	0.006
	7/16	265	0.002	0.006

NOTES

◀ 1 ▶ Numbers are recommended feed rates.

2. Use flood or low pressure heavy mist of cutting fluid for all drilling and reaming.

3. Channel seal groove in aluminum substructure must be filled so graphite epoxy is firmly supported during drilling and reaming.

4. Do not drill more than 10 holes before returning carbide drill for resharpening.

5. High speed steel (HSS) drills may be used if a new or resharpened one is used for each of the specified steps.

6. If required, countersink graphite epoxy for flush head fasteners per paragraph 13, procedure 10 or break edge of graphite epoxy for protruding head fasteners per paragraph 14, procedure 11.

13. **Procedure 10.** See figure 2. Countersinking for flush head fasteners.

a. Countersink with radius, piloted, carbide countersinks, 101725R thru 101832R bodies with 30492R, 30493R, 30496R or 30497R cutters. Rotate at 2000 RPM maximum. Use stopping devices to control countersink depth. Be sure countersink is rotating before it contacts the material to prevent splintering.

b. The hole to countersink junction may have radius for specific fastener installation. A 50° included angle countersink may be used to break the juncture as shown in figure 3.

14. **Procedure 11.** See figure 2. Edge breaking graphite epoxy for protruding head fasteners.

a. Break edge of hole(s) with a diamond plated countersink TD562R2-2. Rotate at 500 RPM.

b. Amount of edge break depends on fastener used.

15. **Trimming.**

a. Circular Sawing.

(1) Use diamond plated blades for cutting graphite epoxy composite when no metal is in joint.

(2) Use diamond impregnated blades for graphite epoxy-metal joints.

(3) Blade speed is 2,000 to 12,000 surface feed per minute (SFPM).

(4) Use hand feed rate that gives good finish cuts.

(5) Material less than 0.250 inch thick requires no cutting fluid.

(6) Material 0.250 or thicker requires use of flood application or low pressure heavy spray mist of cutting fluid.

WARNING

Use vacuum systems and respirators to protect operator(s) during sanding.

b. Sanding. Sand graphite epoxy with 80 to 320 grit abrasive paper.

CAUTION

Abrasive paper used on graphite epoxy must not be used to sand aluminum, and abrasive paper used to sand aluminum must not be used to sand graphite epoxy.

c. Band Sawing.

(1) Use portable band saw equipment operating at 1,000 to 2,000 SFPM with 60 to 80 grit abrasive coated blades for edge trimming.

CAUTION

Masonite backup is required on blade exit side to prevent delaminations and splintering/whitening.

(2) Use stationary band saw equipment operating at 2,000 to 12,000 SFPM with 60 to 80 grit abrasive coated blades for edge trimming.

d. Milling.

CAUTION

Masonite or aluminum backup is required to prevent splintering/whitening/or delaminations. Use flood application or heavy spray mist of cutting fluid during all milling operations.

(1) Use milling machine with carbide end mill cutters on titanium joints.

(2) Use 60 to 90 SFPM cutting speed.

(3) Use climb mill cutting direction (cutter rotation and feed direction causes cutter to try climbing out of work).

e. Routing.

WARNING

Use vacuum system and respirators to protect operator(s) during routing.

(1) When diamond router bits are used, 40 grit tool is recommended for roughing cuts and 100 grit tool is recommended for finishing cuts.

(2) Use router or high speed rotary file motor to prepare edges when no metal is in joint.

(3) Use diamond or carbide router at 1,000 to 6,500 SFPM.

(4) Use climb mill cutting direction.

(5) Use cutting fluid during all power feed routing operations.

16. ARAMID LAMINATE.

Support Equipment Required

NOTE

Alternate item type designations or part numbers are listed in parentheses.

Part Number or Type Designation	Nomenclature
TFIM25.02341 (TFIM25.02342)	High Speed Steel Spur Point, Clothes Pin Point, Center Cutting Drill Bit (Three Fluted Core Drill, Carbide Tipped
TFIM25.014 (TD562P2)	High Speed Steel Countersink Cutters
TR127-121-1169-1TD	Straight Flute Router Bit, Carbide Fullerton Series 1900, 0.250 Inch
TFIM25.0220	Plate Nut Drill
— Fine	High Speed Steel Band Saw Blade, 18 Teeth Per Inch
GGG-M-125/6	Respirator With Cartridge
TFIM25.0202	High Speed Steel Twist Drill

Support Equipment Required (Continued)

NOTE

Alternate item type designations or part numbers are listed in parentheses.

Part Number or Type Designation	Nomenclature
74D110172-1001	Tool Set, Structural Repair, Composite Materials

Materials Required

Specification or Part Number	Nomenclature
BLEEDER LEASE A	Cloth Coated, Peel Ply
—	0.125 Inch Masonite
—	0.125 Inch Aluminum Alloy Sheet, 6061-0
AA1048TY1CL1	Cloth, Abrasive
GRIT240X9X11	
A-A-180, TYPE 2, GRADE B, 0.500 IN.	Tape, Pressure Sensitive

17. Hole Preparation.

CAUTION

To prevent delaminations, use sharp drills.

NOTE

Masonite may be used for backup. Air or water coolant may be used for all cutting operations.

a. Drilling.

(1) Fastener holes 0.093 to 0.375 inch diameter are drilled using High Speed Steel (HSS) spur point, clothes pin point, center cutting drill bit. Rotate drill at 500 to 2,000 RPM and 0.500 inch per minute feed rate. Masonite backup is required.

(2) The 0.070 inch diameter tie yarn holes are drilled using carbide tipped, 3 fluted, clothes

pin point, center cutting drill bit. Rotate drill at 20,000 RPM and 0.500 inch per minute feed rate. Masonite backup is required.

(3) Freehand drilling with standard HSS twist drills rotated at 500 to 2,000 RPM and 0.500 inch per minute feed rate. Aluminum backup is required for both sides.

(4) For larger holes, use piloted core drills rotated at 1,000 RPM and 0.500 inch per minute feed rate. Masonite backup is required on drill exit side.

b. Plate nut drill.

(1) HSS, 2 flute, combination drill and countersink. Sizes are 0.093 to 0.375 inch diameter. Rotate at 6,000 RPM with 0.500 inch per minute feed rate.

(2) Use peel ply for entrance support.

(3) Adjust micro-stop cage to allow for thickness of entrance support material.

(4) Exit side must be backed with 0.125 inch aluminum.

c. Countersinking.

(1) Use standard HSS, 2 flute piloted cutter. Rotate at 2,000 RPM and 0.500 inch per minute feed rate.

(2) Use peel ply for entrance support.

(3) Adjust micro-stop cage to allow for thickness of entrance support material.

18. Trimming.

WARNING

Use vacuum system and respirator to protect operator(s) during sanding operations.

a. Sanding. Sand Aramid laminate with 240 grit abrasive cloth on split shaft, drum, or disc sander. Rotate at 2,000 to 4,000 SFPM.

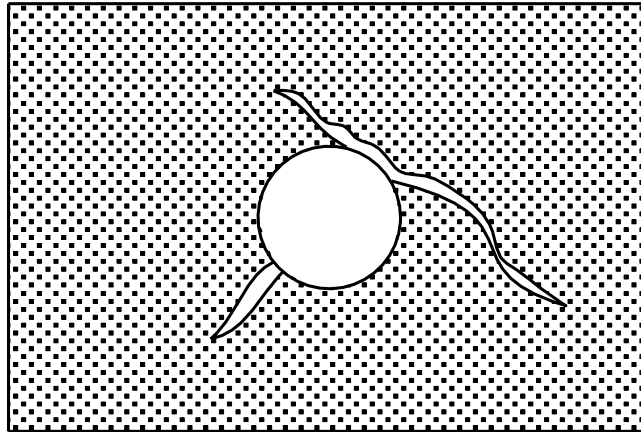
b. Band Sawing.

(1) Use fine HSS blade, 18 teeth per inch.

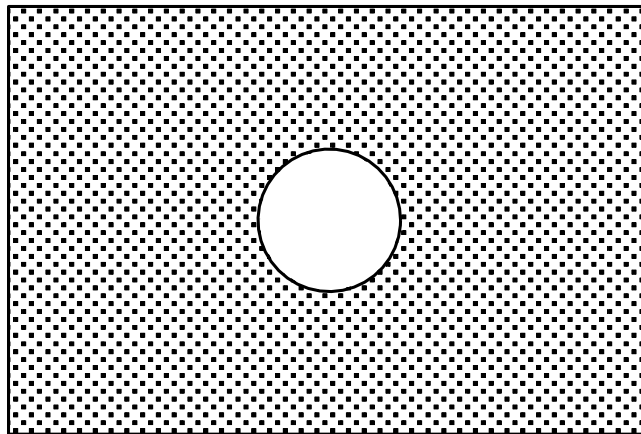
(2) Blade speed should be 2,000 SFPM with 8.0 inch per minute feed rate.

(3) Attach masonite backup using pressure sensitive tape on exit side of part to prevent delaminations.

c. Routing. Use 0.250 inch diameter, straight fluted carbide router bit. Rotate at 10,000 to 16,000 RPM with 30 inch per minute feed rate. Attach masonite backup to both sides using pressure sensitive tape.



BAD
(SPLINTERED)



GOOD

Figure 1. Diagrams of Drilled Hole

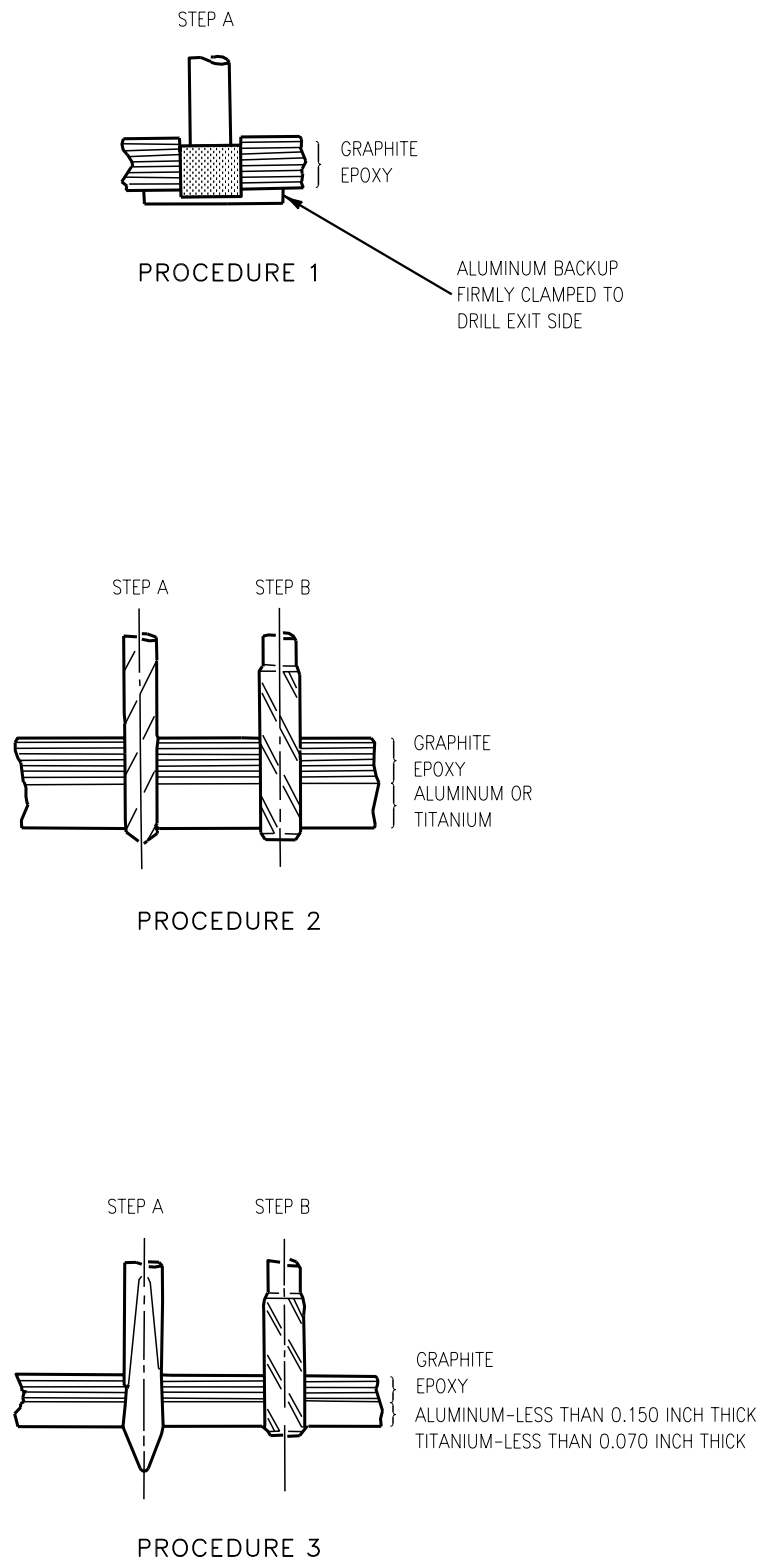
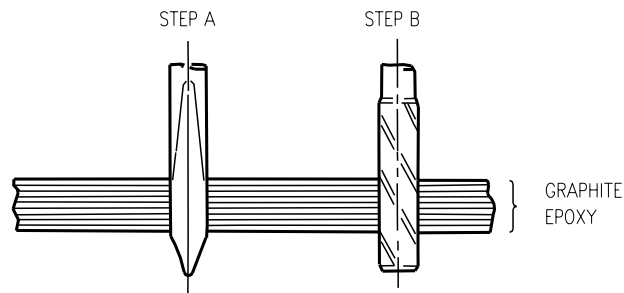
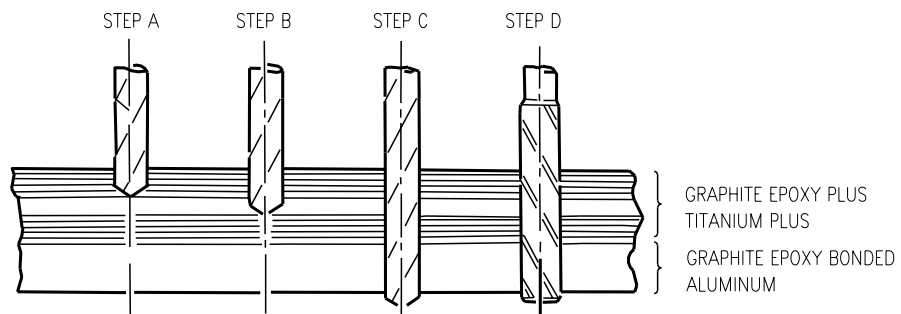


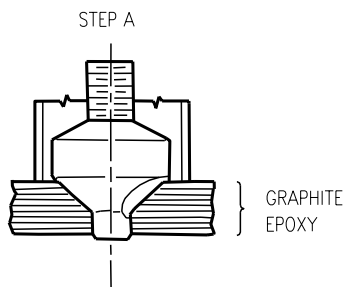
Figure 2. Drilling Graphite Epoxy Composites (Sheet 1)



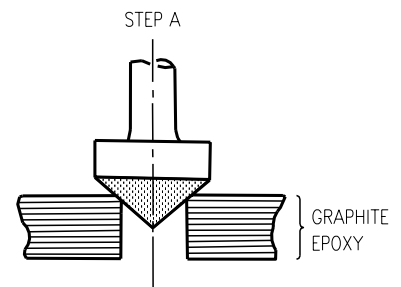
PROCEDURE 6



PROCEDURE 7



PROCEDURE 10



PROCEDURE 11

Figure 2. Drilling Graphite Epoxy Composites (Sheet 2)

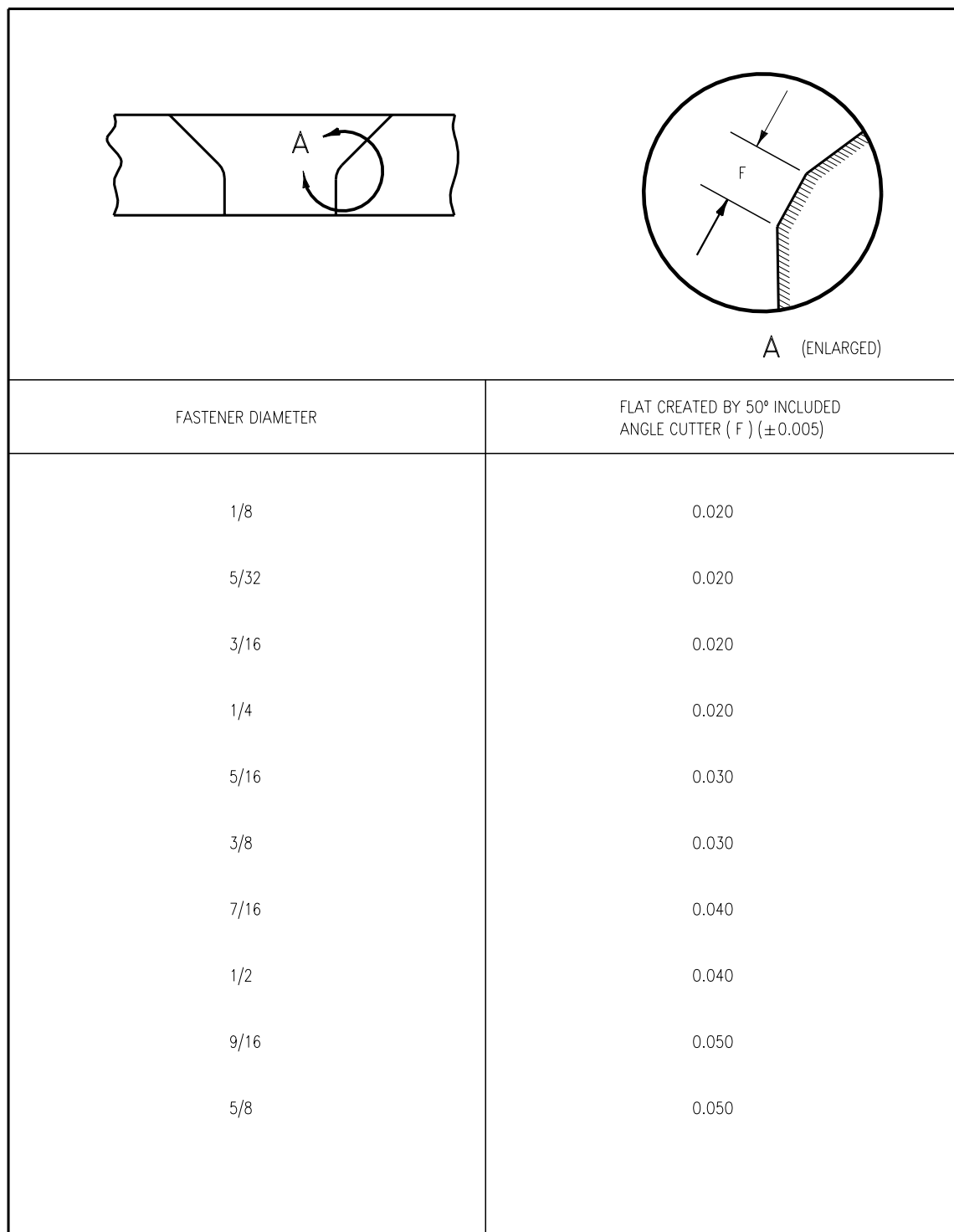


Figure 3. Optional Countersink-to-Hole Juncture Break

ORGANIZATIONAL MAINTENANCE**STRUCTURE REPAIR****SHOP PRACTICES****SUBSTITUTION FASTENERS**

This WP supersedes WP004 09, dated 1 January 1995.

Reference Material

None

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Record of Applicable Technical Directives

None

1. INTRODUCTION.

2. Substitution fasteners are listed by specified number and material and substitution number and material. Fasteners listed are the only ones allowed and depot engineering approval is required for any substitution not covered in this work package.

3. **SUBSTITUTION FASTENERS.** Substitution fasteners are listed in tables 1 through 8 below:

Table 1. Solid Rivets

Type	Specific Fasteners		Substitute Fasteners	
	Part Number	Material	Part Number	Material
Flush Shear Head	BRFS()AD() BRFS()DD()	2117/2024 Al Aly	BRFS()AD() BRFZ()T()	Ti Aly 45T-CB Ti
Flush Shear Head	BRFZ()T() BRFZ4E() BRFZ5E() BRFZ6E() BRFZ8E()	45T-CB Ti 7050-T73 Al Aly 7050-T73 Al Aly 7050-T73 Al Aly 7050-T73 Al Aly	BRFZ()T() BRFZ4T() BRFZ5T() BRFZ6T() BRFZ8E()	45T-CB Ti 45T-CB Ti 45T-CB Ti 45T-CB Ti 7050-T73 Al Aly
Universal Head	MS20470 AD/DD	2117/2024 Al Aly	MS20470 E/T	Ti Aly
MS20426 Head	MS20426 AD/DD	2117/2024 Al Aly	MS20426 E/T	Ti Aly

NOTES

1. Substitution not allowed where rivets contact silver or cadmium.
2. Substitution not allowed in dimpled holes.
3. Substitution not allowed in graphite epoxy composite laminate structure.
4. Substitution not allowed in structure made from aluminum alloys listed below:
 - a. 2024-T851 plate.
 - b. 2124-T851 plate.
 - c. 7050-T736 forging.
 - d. 7050-T73654 forging.
 - e. 7050-T73651 plate.

Table 2. Blind Fasteners

Type	Specific Fasteners		Substitute Fasteners	
	Part Number	Material	Part Number	Material
Olympic Lok				
Flush Head	NAS1399D()A ◀ 1 ▶ 2	2017 Al Aly	NAS1399C()A	A-286 Heat Resis- tant Steel
Protruding Head	NAS1398D()A ◀ 1 ▶ 2	2017 Al Aly	NAS1398C()A	A-286 Heat Resis- tant Steel
Chobert Rivet				
Flush Head	1204() ▶ 1	Cadmium Plated Steel	1415-()	A-286 Heat Resis- tant Steel

Table 2. Blind Fasteners (Continued)

Type	Specific Fasteners		Substitute Fasteners	
	Part Number	Material	Part Number	Material
Blind Bolts				
Flush Head	NAS1674	Al Aly	PLT1058-()-()	Titanium
	PLT170-()-()	Titanium	NAS1672	A-286 Heat Resistant Steel
Protruding Head	NAS1673 ◀ 3	Al Aly	NAS1671	A-286 Heat Resistant Steel
	NAS1673 ◀ 3	Al Aly	PLT270-()-()	Titanium
	PLT270-()-()	Titanium	NAS1671	A-286 Heat Resistant Steel

NOTES

- ◻ 1 Substitution not allowed in structure made from aluminum alloys listed below:
- a. 2024-T851 plate.
 - b. 2124-T851 plate.
 - c. 7050-T736 forging.
 - d. 7050-T73654 forging.
 - e. 7050-T73651 plate.
- ◻ 2 Substitution not authorized if blind side aluminum sheet is less than 0.032 for 1/8 and 5/32 diameter and 0.040 for 3/16 inch diameter fasteners.
- ◻ 3 Substitution not allowed in graphite epoxy composite laminate structure.

Table 3. Bolts

Type	Specific Fasteners		Substitute Fasteners	
	Part Number	Material	Part Number	Material
Flush Reduced Head	HT4016-()-() ◻ 1	PH13-8MO CRES	HT4068-()-()	PH13-8MO CRES (IVD)
	HT291-()-() ◻ 1	PH13-8MO CRES	HT4068-()-()	PH13-8MO CRES (IVD)
	HT4053-()-()	Steel (IVD)	HT4068-()-()	PH13-8MO CRES (IVD)
	HT4053-()D()	Steel (IVD)	HT4068-()-()	PH13-8MO CRES (IVD)
	HT4053-()-() ◻ 2	Steel (IVD)	HT4016-()-()	PH13-8MO CRES (IVD)

Table 3. Bolts (Continued)

Type	Specific Fasteners		Substitute Fasteners	
	Part Number	Material	Part Number	Material
	HT4053-()D() ◀ 2	Steel (IVD)	HT291-()-()	PH13-8MO CRES (IVD)
Flush Full Head	HT4025L()-() ◀ 1	PH13-8MO CRES	HT4057-()-() HT4057-()D()	PH13-8MO CRES (IVD)
	HT295-()-() ◀ 1	PH13-8MO CRES	HT4057-()-() HT4057-()D()	PH13-8MO CRES (IVD)
	HT425L()D() ◀ 1	PH13-8MO CRES	HT4057-()-() HT4057-()D()	PH13-8MO CRES (IVD)
	HT4054-()-() ◀ 2	Steel (IVD)	HT4025L()-() HT295-()-() HT425L()D()	PH13-8MO CRES (IVD)
	HT4054-()D() ◀ 2	Steel (IVD)	HT4025L()-() HT295-()-() HT425L()D()	PH13-8MO CRES (IVD)
	HT4056-()-() ◀ 3	Titanium (IVD)	HT4054-()-() HT4054-()D()	Steel (IVD)
	NAS66()V ◀ 3	6 Al-4V Titanium	HT4025L()-() HT295-()-() HT425L()D()	PH13-8MO CRES (IVD)
Flush Sealing Head	HT271A()-() ◀ 3	6 Al-4V Titanium	HT4020-()-()A HT4020-()-()	PH13-8MO CRES
	HT4020-()-()A HT4020-()-() ◀ 3	PH13-8MO CRES	HT4020-()-()A HT4020-()-()	PH13-8MO CRES PH13-8MO CRES
Hex Head Short Thread	NAS630()U ◀ 4	A-286 Heat Resistant Steel	NAS670()U	A-286 Heat Resistant Steel
	NAS65()V ◀ 4	6 Al-4V Titanium	NAS67()V	6 Al-4V Titanium
	NAS65()V ◀ 2 ◀ 3 ◀ 4 ◀ 5	6 Al-4V Titanium	HT4020-()-()AX HT4020-()-()X	PH13-8MO CRES
Hex Head Long Thread	NAS67()V ◀ 2 ◀ 3 ◀ 4 ◀ 5	6 Al-4V Titanium	HT4020-()-()AX HT4020-()-()X	PH13-8MO CRES

Table 3. Bolts (Continued)

Type	Specific Fasteners		Substitute Fasteners	
	Part Number	Material	Part Number	Material
	NAS670()U <div> <div>3</div> <div>4</div> <div>5</div> </div>	A-286 Heat Resistant Steel	VS3191-()-() VS3191-()D() VS3191-()H() VS3191-()DH()	PH13-8MO CRES
Hex Head	VS3207-()-() <div> <div>3</div> <div>4</div> </div>	Titanium (IVD)	VS3218-()-() VS3218-()D() VS3218-()DH()	Steel (IVD)
	VS3207-()-()D <div> <div>3</div> <div>4</div> </div>	Titanium (IVD)	VS3218-()-() VS3218-()D() VS3218-()DH()	Steel (IVD)
	VS3207-()-()DH <div> <div>3</div> <div>4</div> </div>	Titanium (IVD)	VS3218-()-() VS3218-()D() VS3218-()DH()	Steel (IVD)
Spline Head	VS3191-()-() <div> <div>4</div> <div>5</div> </div>	PH13-8MO CRES	HT4020-()-()AX HT4020-()-()X	PH13-8MO CRES
	VS3191-()D() <div> <div>4</div> <div>5</div> </div>	PH13-8MO CRES	HT4020-()-()AX HT4020-()-()X	PH13-8MO CRES
	VS3191-()H() <div> <div>4</div> <div>5</div> </div>	PH13-8MO CRES	HT4020-()-()AX HT4020-()-()X	PH13-8MO CRES
	VS3191-()DH() <div> <div>4</div> <div>5</div> </div>	PH13-8MO CRES	HT4020-()-()AX HT4020-()-()X	PH13-8MO CRES

NOTES

- 1 Installation in graphite epoxy composite material not allowed. Substitution not allowed if bolthead does not contact aluminum or fiber glass reinforced plastic.
- 2 Substitution not allowed for service-removable fasteners, example; door and access panel attachments or panel attachments.
- 3 Substitution not allowed in non-magnetic applications.
- 4 Substitution not allowed where protrusion into bladder type fuel tank would be increased. Shape of substitute bolt differs from specified bolt. Make sure of enough clearance, no threads in bearing, correct protrusion, alignment of cotter pin holes, and engagement of cotter pins in nut slots when installing.
- 5 Use correct size NAS1587-()C washer under bolt head to clear head to shank fillet radius.

Table 4. Screws and Nuts

Type ◀ 2	Specific Fasteners		Substitute Fasteners	
	Part Number	Material	Part Number	Material
Screws				
Pan Head, Phillips	NAS60() ◀ 1	Cadmium Steel	NAS1801	Alloy Steel
Hex Head, Phillips	NAS1801	Cadmium Steel	NAS1802	A-286 Heat Resistant Steel
Socket Head, Cap	80860C3()()	A-286 Resistant Steel		
Nuts				
Hex, Self Locking	NAS1291C ◀ 1	A-286 Heat Resistant Steel	HW49660-()	A-286 Heat Resistant Steel
Hex, Castellated	74640-() ◀ 1	Cadmium Steel	74640C()	A-286 Heat Resistant Steel
	74640C() ◀ 1	A-286 Heat Resistant Steel	H52351-()	A-286 Heat Resistant Steel
	74642-()A ◀ 1	A-286 Heat Resistant Steel	79219-()	Inconel
	AN310 ◀ 1	Cadmium Steel	79219-() 79219-()	Inconel
	AN310C ◀ 1	300 SERIES CRES	79219-() 79219-()	Inconel
	MS21244-()	Cadmium Steel	MS21244-()C	A-286 Heat Resistant Steel

NOTES

- ◀ 1 ▶ Substitution not allowed where protrusion into bladder type fuel tank would be increased. Shape of substitute fastener(s) differs from specified fastener(s). Make sure of enough clearance, no threads in bearing, correct protrusion, alignment of cotter pin holes, and engagement of cotter pins in nut slots when installing.
- ◀ 2 ▶ See table 9 for torque limits.

Table 5. Plate Nuts

Type	Specific Fasteners		Substitute Fasteners	
	Part Number	Material	Part Number	Material
Two Lug	MS21060L ◀ 1	A-286 Heat Resistant Steel	F50339-()-()	A-286 Heat Resistant Steel
	F49249E()-() ◀ 1 ◀ 2	A-286 Heat Resistant Steel	F50339-()-()	A-286 Heat Resistant Steel
	F14421-()-()	Cadmium Steel	F49249E()-()	A-286 Heat Resistant Steel
	F50339-()-() ◀ 1 ◀ 3	A-286 Heat Resistant Steel	F49249E()-()	A-286 Heat Resistant Steel
One Lug	MS21062L ◀ 1	A-286 Heat Resistant Steel	F50340-()-()	A-286 Heat Resistant Steel
	F49251E()-() ◀ 1 ◀ 2	A-286 Heat Resistant Steel	F50340-()-()	A-286 Heat Resistant Steel
	RMF19427-()-()	Cadmium Steel	F49251E()-()	A-286 Heat Resistant Steel
	F50340-()-() ◀ 1 ◀ 3	A-286 Heat Resistant Steel	RMF19427-()-()	Cadmium Steel
Corner	NIS103597-() ◀ 1	A-286 Heat Resistant Steel	F50403-()-()	A-286 Heat Resistant Steel

NOTES

- ◀ 1 Substitution not allowed where protrusion into bladder type fuel tank would be increased. Shape of substitute plate nut(s) differs from specified plate nut(s). Make sure of correct clearance and correct protrusion.
- ◀ 2 Substitution not allowed for service-removable fasteners, example; door and access panel attachments or panel attachments.
- ◀ 3 Threaded fasteners with unsafetied nuts or collars and replaceable nut plate nuts shall not be used in locations where components of fastener could be ingested by engine.

Table 6. Hi-Lok Pins and Collars

Type	Specific Fasteners		Substitute Fasteners	
	Part Number	Material	Part Number	Material
Hi-Lok Pins				
Flush, Shear Head	HLT311TA()-() ◀ 1	6 Al-4V Titanium	HLT51TB()-()	PH13-8MO CRES

Table 6. Hi-Lok Pins and Collars (Continued)

Type	Specific Fasteners		Substitute Fasteners	
	Part Number	Material	Part Number	Material
	HLT311-()-() ◀ 1	6 Al-4V Titanium	HLT51TB()-()	PH13-8MO CRES
	HLT51TB()-() ◀ 2 ▶ 3 ◀ 4	PH13-8MO CRES	HT4024L()-() HT4024L()D() HT4024L()-()M HT4024L()D()M NAS1291C()M	PH13-8MO CRES/ A-286 Heat Resis- tant Steel A-286 Heat Resis- tant Steel
Flush, Tension Head	HLT313TA()-() ◀ 1	Titanium	HLT313TB	PH13-8MO CRES
	HLT313-()-() ◀ 1	Titanium	HLT313TB	PH13-8MO CRES/ Inconel
	HLT313TB()-() ◀ 2 ▶ 3 ◀ 4	PH13-8MO CRES	HT4025L()-() HT295-()-() HT4025L()D() H50609-()	PH13-8MO CRES Inconel
Protruding Shear Head	HLT310TA()-() ◀ 1	Titanium	HLT50TB()-()	PH13-8MO CRES
	HLT310-()-() ◀ 1	Titanium	HLT50TB()-()	PH13-8MO CRES
	HLT50YB-()-()	PH13-8MO CRES	HLT52YC-()-()	PH13-8MO CRES
Protruding Tension Head	HLT312TA()-() ◀ 1	Titanium	HLT52TB()-()	PH13-8MO CRES
	HLT312-()-() ◀ 1	Titanium	HLT52TB()-()	PH13-8MO CRES
Hi-Lok Collars				
Twist Off	HL570-()MC ◀ 5 ▶ 6	2024 Al Aly	SW1000-()M	A-286 Heat Resis- tant Steel
	HL570-()MC ◀ 1 ▶ 5 ◀ 6	2024 Al Aly	HL582-()MCA SW2000-()W	2024 Al Aly Stainless Steel
	SW1000-()M ◀ 1 ▶ 5 SW1000-()M ◀ 1	A-286 Heat Resis- tant Steel A-286 Heat Resis- tant Steel	SW2000-()A SW2000-()W SW2000-()A SW2000-()W	CRES Stainless Steel CRES Stainless Steel

Table 6. Hi-Lok Pins and Collars (Continued)

Type	Specific Fasteners		Substitute Fasteners	
	Part Number	Material	Part Number	Material
Self-Aligning	HL582-()MCA	2024-T6 Al Aly	SW2000-()A	CRES
HL582-()MCA	2024-T6 Al Aly 6 SW2000-()W	H51120A() Stainless Steel	A-286 Heat H51120A()	Resistant Steel A-286 Heat Resis- tant Steel

NOTES

- 1 Substitutions not allowed in non-magnetic applications.
- 2 Substitution not allowed where protrusion into bladder type fuel tank would be increased. Shape of substitute fastener differs from specified fastener. Make sure of enough clearance and correct protrusion.
- 3 Substitution not allowed in interference fit or class I holes.
- 4 Use correct size AN960JD washer between collar and aluminum structure. Use correct size AN960C washer between collar and titanium or steel structure. Use correct size AN960C washer between collar and composite structure and fay surface seal.
- 5 Where collar contacts aluminum structure, substitution requires engineering approval. CRES collars may be seated against aluminum structure only if area is sheltered and well drained.
- 6 Shape of substitute differs from specified item. Inspect for correct clearance, no threads in bearing, correct protrusion, cotter pin hole alignment, and cotter pin engagement in nut slots. Substitution not allowed where protrusion into bladder type fuel tank would be increased.

Table 7. Lockbolts

Type	Specific Fasteners		Substitute Fasteners	
	Part Number	Material	Part Number	Material
Lockbolt Pins				
Flush, Shear Head, Stump Type	NAS270()V 1 2 3 4	6 Al-4V Titanium	HLT311TA()-() HLT311-()-() SW1000-()M	6 Al-4V Titanium/ A-286 Heat Resis- tant Steel A-286 Heat Resis- tant Steel
	NAS270()V 5	Al-4V Titanium	2705 MU-()	PH13-8MO CRES
	SLS1000CT-() EU()-() 5	A-286 Heat Resis- tant Steel	2705 MU-()	PH13-8MO CRES
	2705MU-() 1 2 3 4	PH13-8MO CRES	HLT51TB()-() SW1000-()M	PH13-8MO CRES A-286 Heat Resis- tant Steel

Table 7. Lockbolts (Continued)

Type	Specific Fasteners		Substitute Fasteners	
	Part Number	Material	Part Number	Material
	ST3M861V05 ◀ 1 ▶ 2 ◀ 3 ▶ 4	6 Al-4V Titanium	HLT311TA()-() SW1000-()M	6 Al-4V Titanium/ A-286 Heat Resis- tant Steel
Protruding, Shear Head, Stump Type	NAS1424	Cadmium Steel	SLSPCT-EU4-()	Heat Resistant Steel
	NAS1425	Cadmium Steel	SLSPCT-EU5-()	A-286 Heat Resis- tant Steel
	NAS1426-()	Cadmium Steel	NAS1446 NAS1452	Cadmium Steel
	NAS260()V ◀ 1 ▶ 2 ◀ 3 ▶ 4	Al-4V Titanium 6	HLT310TA()-() SW1000-()M	6 Al-4V Titanium/ A-286 Heat Resis- tant Steel
	NAS260()V ◀ 5 ▶	6 Al-4V Titanium	2601MU()	PH13-8MO CRES
	SLSPCT-EU()-() ◀ 5 ▶	A-286 Heat Resis- tant Steel	2601MU()	PH13-8MO CRES
	2605MU() ◀ 1 ▶ 2 ◀ 3 ▶ 4	PH13-8MO CRES	HLT50TB()-() SW1000-()	PH13-8MO CRES A-286 Heat Resis- tant Steel
	VLB244-()-() ◀ 1 ▶ 2 ◀ 3 ▶ 4	6 Al-4V Titanium	HLT310TA()-() SW1000-()	6 Al-4V Titanium/ A-286 Heat Resis- tant Steel
Flush, Shear Head, Pull Type	VLB238-()-() ◀ 5 ▶	6 Al-4V Titanium	VLB239-()-()	PH13-8MO CRES
	VLB238-()-() ◀ 1 ▶ 2 ◀ 3 ▶ 4	6 Al-4V Titanium	HLT311TA()-() HLT311-()-() SW1000-()M	6 Al-4V Titanium/ A-286 Heat Resis- tant Steel
	VLB239-()-() ◀ 1 ▶ 2 ◀ 3 ▶ 4	PH13-8MO CRES	HLT51TB()-() SW1000-()M	PH13-8MO CRES /A-286 Heat Resis- tant Steel
Flush, Tension Head, Pull Type	VLB234-()-() ◀ 1 ▶ 2 ◀ 3 ▶ 4	PH13-8MO CRES	HLT53TB()-() SW1000-()M	PH13-8MO CRES/ A-286 Heat Resis- tant Steel

Table 7. Lockbolts (Continued)

Type	Specific Fasteners		Substitute Fasteners	
	Part Number	Material	Part Number	Material
Protruding Shear Head, Pull Type	VLB237-()-() ◀ 5	6 Al-4V Titanium	VLB235-()-()	PH13-8MO CRES
	VLB237-()-() ◀ 1 ◀ 2 ◀ 3 ◀ 4	6 Al-4V Titanium	HLT310TA()-() HLT310-()-() SW1000-()M	PH13-8MO CRES/ A-286 Heat Resis- tant Steel
	VLB235-()-() ◀ 1 ◀ 2 ◀ 3 ◀ 4	6 Al-4V Titanium	HLT50TB()-() SW1000-()M	PH13-8MO CRES/ A-286 Heat Resis- tant Steel

NOTES

- ◀ 1 ▶ Substitution not allowed where protrusion into bladder type fuel tank would be increased. Shape of substitute fastener differs from specific fastener. Make sure of enough clearance and correct protrusion.
- ◀ 2 ▶ Threaded fasteners with unsafetied nuts or collars and replaceable nut plate nuts shall not be used in locations where components of fastener could be ingested by engine.
- ◀ 3 ▶ Threaded fasteners with unsafetied nuts or collars shall not be used for attaching control surface hinges and hinge brackets.
- ◀ 4 ▶ Engineering approval required if collar of substitution fastener contacts aluminum structure. CRES collars may be seated against aluminum structure only if area is sheltered and well drained.
- ◀ 5 ▶ Substitution not allowed in non-magnetic applications.



Table 8. Eddie-Bolts

Specific Fasteners ▶ 1 ▶		Substitute Fasteners	
Part Number	Material	Part Number	Material
EB1120N6A()	6AL-4V Titanium	EL1201NC6-()A	6AL-4V Titanium
EB1120N8A()	6AL-4V Titanium	EL1201NC8-()A	6AL-4V Titanium


NOTE

- ◀ 1 ▶ When required grip length(s) is not available, specified fastener(s) up to 2 grip lengths longer than required may be used with addition of a washer. AN960JD washer between nut or collar and aluminum structure. AN960C washer between nut or collar and titanium or steel structure. AN960C washer between nut or collar and composite structure and fay seal between washer and composite structure. This additional length is limited to where additional length will not compromise clearance to structure, components, or moving mechanisms.

Table 9. Torque Limits (Inch-Pounds)

Nominal Size	Fastener Head Type	
	Tension	Shear
#10	20 - 25	12 - 15 
1/4	50 - 70	30 - 40 
5/16	100 - 140	60 - 85
3/8	160 - 190	95 - 110

**Table 9. Torque Limits (Inch-Pounds)
(Continued)**

Nominal Size	Fastener Head Type	
	Tension	Shear
NOTES  Use tension torque values for self-locking nuts.		

DEPOT MAINTENANCE

STRUCTURE REPAIR

GENERAL INFORMATION

COLD WORKING FASTENER HOLES

Reference Material

Structure Repair, General Information	A1-F18AC-SRM-200
Cold Working Fastener Hole Tool Set Part No. RE174000002-1	WP004 20

Alphabetical Index

Subject	Page No.
Introduction	1
Procedures	2

Record of Applicable Technical Directives

None

1. INTRODUCTION. See figure 1.

2. Split sleeve cold working increases fatigue life of fastener holes. Hole is cold worked by placing a stainless steel split sleeve on a mandrel which is inserted into a reamed hole and pulling mandrel through split sleeve. The axial ridge formed on hole wall by split sleeve is removed by reaming hole to final size. For instructions on the use of cold working fastener hole tool set (WP004 20).

Support Equipment Required
(Continued)

NOTE

Alternate item type designations or part numbers are listed in parentheses.

Support Equipment Required

NOTE

Alternate item type designations or part numbers are listed in parentheses.

Part Number or Type
Designation

Nomenclature

TFIM 25.0214

Drills

Part Number or Type
Designation

Nomenclature

TFIM 25.113

Reamers, For Non-Bushed Tooling, Not Recommended For Holes Greater Than 3/8-Inch Dia.

TFIM 25.111

Reamers, For Bushed Tooling

1ED12-545

Hydraulic Pump

1E12-408 (1E12-422)

Nose Assembly, For Open Access Areas

1E12-392

Nose Assembly, For Limited Access Areas

Support Equipment Required (Continued)

NOTE

Alternate item type designations or part numbers are listed in parentheses.

Part Number or Type Designation

Nomenclature

TD5016A-1E	Jaw Assembly, For Use With 1E12-408 or 1E12-392 Nose Assem- bly
TD516B-1E	Jaw Assembly, For Use With 1E12-408 or 1E12-392 Nose Assem- bly
TD5016G-1E	Jaw Assembly, For Use With 1E12-422 Nose Assembly
TD5016U-1E	Jaw Assembly, For Use With 1E12-422 Nose Assembly
TD761D	Mandrels, For Open Access Areas
TD761L	Mandrels, For Limited Access Areas
TD761H	Sleeves, 5/32 Thru 3/8- Inch Dia.
TD761G	Sleeves, 7/16-Inch and Larger Dia. or For Stacking Sleeves in Material Thicknesses Greater Than 1-5/16 Inch
TD216G5	Plug Gages, For In- specting Pre-Cold Work and After Cold Work Hole Dia.

Materials Required

None

3. PROCEDURES.

4. Pre-Cold Work Hole Preparation and Inspection.

- a. Determine nominal final hole size.

- b. Use table 1 to determine pre-cold work hole diameter.

- c. Pre-drill hole approximately 1/64-inch undersize per table 1.

- d. Ream hole to pre-cold work diameter.

- (1) Use piloted reamers for free hand reaming, up through 3/8-inch diameter.

- (2) Use machine reamers for reaming through bushed tooling, mandatory for 7/16-inch and larger diameter.

- e. Inspect pre-cold work hole 100 percent, figure 1.

- (1) Use stepped shank end of inspection gage. Step 1 shall GO into hole. Step 2 shall NOT GO into hole.

- (2) Inspect hole in two directions 90° apart to be sure an out of round condition does not exist.

5. Cold Working and Post Cold Working Inspection.

- a. Make sure hole is clean and free from dirt and chips and multiple structural members are firmly clamped together.

- b. Select correct cold working equipment.

- c. Select correct mandrel and sleeve from table 2.

- (1) Measure mandrel diameter A. Make sure it is not less than 0.0002 inch below minimum specified diameter, figure 1.

- (2) Select sleeve length. Make sure sleeve extends a minimum 0.02 inch past maximum material thickness, figure 1.

NOTE

Sleeve may be any length as long as it extends the minimum 0.02 inch past maximum material thickness.

- d. Attach mandrel to mandrel puller, nose assembly.

- e. Slide sleeve over mandrel and back against jaw assembly in end of nose assembly. When using

TD761H sleeves, make sure flared end of sleeve seats against jaw assembly.

f. Slip mandrel and sleeve into hole until end of nose assembly contacts structure.

g. Actuate puller to pull mandrel through sleeve and cold work hole. Orientation of sleeve split is optional.



Never reuse a sleeve, damage to hole or incorrect cold working may result.

h. Remove sleeve from hole and dispose.

i. Inspect cold worked hole 100 percent, figure 1.

(1) Use non-stepped shank end of inspection gage. Step 3 shall GO into hole.

(2) Orient flat portion of inspection gage with ridge in hole resulting from split sleeve.

6. Final Hole Sizing, Countersinking, and Inspection.

a. Final ream and countersink hole as specified.

NOTE

Cold working deformation results in localized thickening of metal near hole edge. This causes a slight separation of fastener and part. The gap shall not exceed 0.005 inch between fasteners, and shall not allow contact of 0.002 feeler gage with fastener shank unless specifications allow a larger gap to exist.

b. Inspect final hole size specified.

7. Oversize Requirement.

NOTE

A depot engineering disposition is required for all oversized conditions.

a. Do pre-cold work hole preparation and inspection, paragraph 4 , for first or second oversize.

b. Do cold working and post cold working inspection, paragraph 5, for first or second oversize.

c. Do final hole sizing, countersinking, and inspection, paragraph 6, for first or second oversize per depot engineering disposition.

d. Re-cold working is not required if specified final oversize hole diameter is not more than 1/64 inch over specified diameter. Ream hole to specified oversize diameter.

e. If specified final oversize hole diameter is more than 1/64 inch over specified diameter, re-cold working is required. Re-cold work hole using parameters specified on depot engineering disposition.

Table 1. Pre-Cold Work Hole Preparation and Inspection








































Nominal Final Hole Diameter	Pre-Cold Work Hole				Inspection Gage (TD216G5-)
	Diameter +0.003 −0.000	Recommended Cutters			
		Pre-Drill (TFIM25.0214)	Reamer		
			Piloted (TFIM25.113−)	Non-Piloted (TFIM25.111−)	
5/32 5/32 	0.1430 0.1590	0.1285 (#30) —	0.1432×0.1263 0.1592×0.1410	0.1432 —	05 051
3/16 3/16  3/16 	0.1770 0.1926 0.2082	0.1610 (#20) — —	0.1772×0.1588 0.1928×0.1750 0.2084×0.1906	0.1772 — —	30 31 32
1/4 1/4  1/4 	0.2350 0.2510 0.2667	0.2188 (7/32) — —	0.2352×0.2166 0.2512×0.2330 0.2669×0.2490	0.2352 — —	40 41 42
5/16 5/16  5/16 	0.2970 0.3131 0.3293	0.2812 (9/32) — —	0.2972×0.2790 0.3133×0.2950 0.3295×0.3111	0.2972 — —	50 51 52
3/8 3/8  3/8 	0.3590 0.3751 0.3917	0.3438 (11/32) — —	0.3592×0.3416 0.3753×0.3570 0.3919×0.3731	0.3592 — —	60 61 62
7/16 7/16  7/16 	0.4210 0.4371 0.4512	0.4062 (13/32) — —	— — —	0.4212 0.4373 0.4514	70 71 72
1/2 1/2  1/2 	0.4745 0.4901 0.5062	0.4531 (29/64) — —	— — —	0.4747 0.4903 0.5064	80 81 82
9/16 9/16  9/16 	0.5370 0.5526 0.5687	0.5156 (33/64) — —	— — —	0.5372 0.5528 0.5689	90 91 92
5/8 5/8  5/8 	0.5975 0.6131 0.6317	0.5781 (37/64) — —	— — —	0.5917 0.6073 0.6259	100 101 102
3/4 3/4 	0.7185 0.7341	— —	— —	— —	120SPL 121
NOTES					
 First oversize					
 Second oversize					


Table 2. Mandrels, Sleeves, and Inspection Gages

Nominal		Mandrel	Sleeve	Inspection Gage TD216G5–
Final Hole Diameter	Part Number (TD761D/L–)	Diameter ± 0.0002	Part Number (TD761) 	
5/32 5/32 	050 051	0.1400 0.1560	H-050XX H-051XX	05 051
3/16 3/16 	30 31	0.1740 0.1896	H-30XX H-31XX	30 31
3/16 	32	0.2052	H-32XX	32
1/4 1/4 	40 41	0.2300 0.2460	H-40XX H-41XX	40 41
1/4 	42	0.2617	H-42XX	42
5/16 5/16 	50 51	0.2940 0.3101	H-50XX H-51XX	50 51
5/16 	52	0.3223	H-52XX	52
3/8 3/8 	60 61	0.3540 0.3701	H-60XX H-61XX	60 61
3/8 	62	0.3867	H-62XX	62
7/16 7/16 	70 71	0.4180 0.4341	G-70XX G-71XX	70 71
7/16 	72	0.4482	G-72XX	72
1/2 1/2 	80 81	0.4695 0.4851	G-80XX G-81XX	80 81
1/2 	82	0.5012	G-82XX	82
9/16 9/16 	90 91	0.5340 0.5496	G-90XX G-91XX	90 91
9/16 	92	0.5657	G-92XX	92
5/8 5/8 	100 101	0.5915 0.6071	G-100XX G-101XX	100 101
5/8 	102	0.6257	G-102XX	102
3/4 3/4 	120 121	0.7165 0.7321	G-120XX G-121XX	120 121

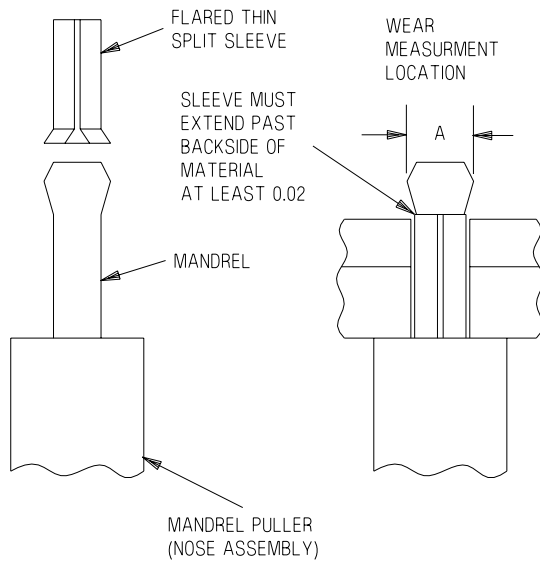
NOTES

 XX - Sleeve length in 1/16 inch increments, sleeve must protrude minimum of 0.02 through material, see figure 1.

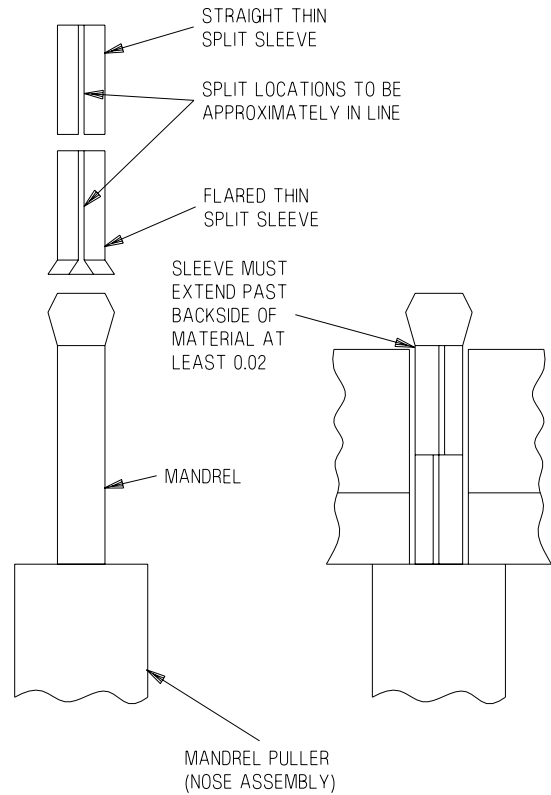
 First oversize.

 Second oversize.

MATERIAL STACKUP LESS THAN 1.3125



MATERIAL STACKUP GREATER THAN 1.3125

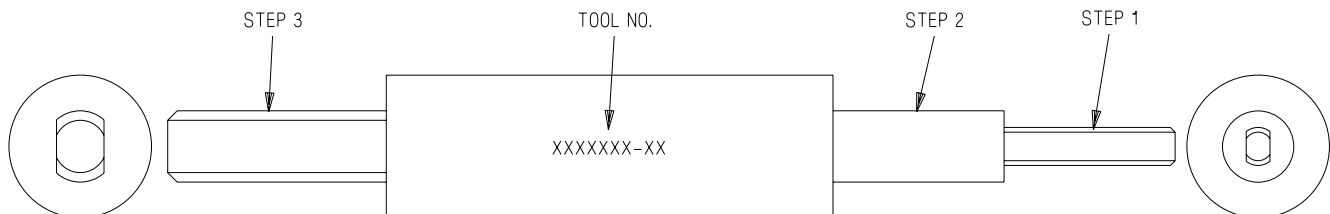


MANDREL
TD761D-40

- 0-NOMINAL SIZE
- 1-1/64 OVERSIZE
- 2-1/32 OVERSIZE
- NOMINAL FINAL HOLE DIAMETER IN SIXTEENTHS
- MANDREL BASIC NUMBER

SPLIT SLEEVE
TD761G-4016

- SLEEVE LENGTHS IN SIXTEENTHS
- 0-NOMINAL SIZE
- 1-1/64 OVERSIZE
- 2-1/32 OVERSIZE
- NOMINAL FINAL HOLE DIAMETER IN SIXTEENTHS
- SLEEVE BASIC NUMBER
- TD761G-STRAIGHT- FOR ALL MATERIALS
- TD761H-FLARED-FOR 3/8 AND SMALLER DIAMETER HOLES IN ALL MATERIALS



HOLE INSPECTION GAUGE FOR SPLIT SLEEVE COLD WORKING

Figure 1. Cold Working Fastener Holes.

INTERMEDIATE MAINTENANCE

STRUCTURE REPAIR

SHOP PRACTICES

HEAT TREATMENT OF ALUMINUM ALLOYS

Reference Material

General Manual for Structural Repair	NAVAIR 01-1A-1
Engineering Series for Aircraft Repair	NAVAIR 01-1A-9

Alphabetical Index

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Heat Treatment.....	1
Heat Treatment Procedures, Table 1	1
Maximum Thickness at Times of Solution Heat Treating, Table 3	5
Soaking Times for Solution Heat Treatment of Wrought Aluminum Alloys, Table 2	4

Record of Applicable Technical Directives

None

1. HEAT TREATMENT.

2. Heat treatment is a series of controlled heating and cooling operations used to get required conditions or properties, such as strength or ductility, in a solid metal or alloy. Heat treatment

procedures given are for aluminum alloy in the annealed condition. Tables 1, 2 and 3 contain aluminum alloy heat treatment procedures. Additional information on heat treatment is found in NAVAIR 01-1A-1 and NAVAIR 01-1A-9.

Table 1. Heat Treatment Procedures

Material, Form, Desired Condition	Solution Heat Treat Temp <input type="text" value="1"/> (Degrees F)	Time at Temp	Quench	Age (Degrees F)	Final Heat Treat Condt.
2024/2124 Sheet -T72 <input type="text" value="2"/>	920 ±10	Table 2	Rapidly in water or glycol solution. (AQ/W) <input type="text" value="3"/>	375 ±10 for 16 hours.	T72
Bar and Ex- trusion -T6 <input type="text" value="2"/>	920 ±10	Table 2	Rapidly in water (AQ/W) <input type="text" value="3"/>	375 ±10 for 15 - 17 hours.	T62 <input type="text" value="4"/>

Table 1. Heat Treatment Procedures (Continued)

Material, Form, Desired Condition	Solution Heat Treat Temp 1 (Degrees F)	Time at Temp	Quench	Age (Degrees F)	Final Heat Treat Condt.
Drawn Tube -T6 2	920 ±10	Table 2	Rapidly in water (AQ/W) 3	375 ±10 for 9 - 10 hours.	T62 4
Sheet -T81 5 Plate -T851 5 Extrusion -T85XX 5	—	—	—	375 ±10 for 11 - 13 hours. 6	T81 T851 T85XX
2219 Forging -T6	995 ±10	Table 2	Rapidly in cold water (AQ/W) 3	375 ±10 for 25 - 27 hours.	T62 4
Forging -T-8	—	—	—	350 ±10 for 17 - 19 hours.	T8
6061 Sheet and Tube -T4	985 ±10	Table 2	Rapidly in water or Glycol Solution (AQ/W) 3	Room Temp for 96 hours.	T42 4
All Forms -T6 2	985 ±10	Table 2	Rapidly in water (AQ/W) 3	350 ±10 for 8 - 9 hours.	T62 4
7049/7149 Forging -T73, -T735X	875 ±10	Table 2	Rapidly in water not exceeding 160 degrees F or in glycol solution (AQ/W) 3	Three steps: One: Room temp for 48 hours min. Two: 250 ±10 for 24 - 25 hours. Three: 330 ±10 for 10 - 14 Hours	T73
Extrusion -T73, -T735XX	875 ±10	Table 2	Rapidly in water (AQ/W) 3	Three steps: One: Room temp for 48 hours min. Two: 250 ±10 for 24 - 25 hours. Three: 330 ±10 for 20 - 22 hours for thickness up to 2.0 inches or 13 - 15 hours for thickness over 2 inches.	T73

Table 1. Heat Treatment Procedures (Continued)

Material, Form, Desired Condition	Solution Heat Treat Temp 1 (Degrees F)	Time at Temp	Quench	Age (Degrees F)	Final Heat Treat Condt.
7050 Forging -T736, -T7365X	880 ±10	Table 2	Rapidly in water not exceeding 160 degrees F or in glycol solution (AQ/W) 3	Two steps: One: 250 ±10 for 3 - 6 hours. Two: 350 ±10 for 6 - 10 hours.	T736
Extrusion Plate -T736, -7365X	890 ±10	Table 2	Rapidly in water or glycol solution (AQ/W) 3	Two steps: One: 250 ±10 for 7 - 9 hours. Two: 350 ±10 for 9 - 11 hours.	T736
7075 Sheet -T6 2	860 - 930 6	Table 2	Rapidly in water gly- col solution (AQ/W) 3	250 ±10 for 23 - 25 hours.	T62
Sheet -T76 -T7651 7	860 - 930 10	Table 2	Rapidly in water or glycol solution (AQ/W) 3	Two Steps: One: 250 ±10 for 5 - 8 hours. Two: 330 ±10 for 15 - 18 hours.	T76
Extrusion --T76 -T765XX 7	870 ±10	Table 2	Rapidly in water (AQ/W) 3	Two Steps: One: 250 ±10 for 5 - 8 hours. Two: 320 ±10 for 18 - 21 hours.	T76
Bar Forging Plate -T73 -T735X 7	870 ±10	Table 2	Rapidly in water or glycol solution. Forg- ings may be quenched in water not exceed- ing 160 degrees F. (AQ/W) 3	Two Steps: One: 225 ±10 for 6 - 8 hours. Two: 350° ±10 for 8 - 10 hours. 8 9	T73
Extrusion -T735XX 7	870 ±10	Table 2	Rapidly in water (AQ/W) 3	Two Steps: One: 225 ±10 for 6 - 8 hours. Two: 350 ±10 for 6 - 8 hours.	T73
A356 Casting -T61	980 - 1010	6 - 8 hours	In water at 150 - 212 degrees F. (W) 3	310 ±10 for 6 - 10 hours.	T61

NOTES

Table 1. Heat Treatment Procedures (Continued)

Material, Form, Desired Condition	Solution Heat Treat Temp <div>1</div> (Degrees F)	Time at Temp	Quench	Age (Degrees F)	Final Heat Treat Condt.
<div>1</div> See table 3 for maximum thickness at time of solution heat treatment. <div>2</div> Material in -T4 or -T4X condition requires only aging. <div>3</div> Unstable condition. <div>4</div> Additional digit, 2, means heat treatment by other than mill supplier. <div>5</div> This temper provided by producer or can only be reached by aging from -T3, -T351, or -T3511 temper. Temper -T8 cannot be restored by reheat treatment. <div>6</div> For sections over 0.500 inch thick, add 1/2-hour for each additional 0.500 inch of thickness. <div>7</div> Material in -T6 or -T6X condition requires only second aging step. <div>8</div> Parts may be given up to 6 hours additional aging at specific temperature to meet requirements. <div>9</div> May be alternately heated, for step 2, to 325 degrees F $\pm 10^\circ$ ba degrees F for 24 - 30 hours if heavy load or slow. <div>10</div> Blistering may occur above 880 degrees F.					

Table 2. Soaking Times for Solution Heat Treatment of Wrought Aluminum Alloys

Thickness, Inches	Soaking Time, Minutes			
	Salt Bath		Air Furnace	
	Minimum	Maximum (Alclad Only)	Minimum	Maximum (Alclad Only)
0.016 and under	10	15	20	25
0.017 to 0.020	10	20	20	30
0.021 to 0.032	15	25	25	35
0.033 to 0.063	20	30	30	40
0.064 to 0.090	25	35	35	45
0.091 to 0.125	30	40	40	50
0.126 to 0.250	35	45	50	60
0.251 to 0.500	45	55	60	70
0.501 to 1.000	60	70	90	100
1.001 to 1.500	90	100	120	130
1.501 to 2.000	105	115	150	160
2.001 to 2.500	120	130	180	190
2.501 to 3.000	150	160	210	220
3.001 to 3.500	165	175	240	250
3.501 to 4.000	180	190	270	280
Over 4.00	<div>1</div>		<div>2</div>	

NOTES

1

Add 15 minutes for each additional 1/2-inch.

2

Add 30 minutes for each additional 1/2-inch.

Table 3. Maximum Thickness at Time of Solution Heat Treating

Alloy	Form	Maximum Thickness (Inches)	Glycol Concentration	
			Type I (Percent)	Type II (Percent)
Water Quench				
2024/2124 2219 6061	All	4.0	—	—
7049/7149 7050	All	5.0	—	—
7075	All	3.0	—	—
Glycol Quench				
2024/2124	Sheet	0.125	18 - 22	16 - 18
6061	Sheet	0.180	18 - 22	16 - 18
7049/7149	Forging	3.0	10 - 12	—
7050	Forging	4.0	10 - 12	—
		1.0	20 - 22	—
	Extrusion	3.0	10 - 12	—
7075	Sheet	0.250	20 - 22	16 - 18
	Forging	1.0	20 - 22	16 - 18
		2.5	10 - 12	—

ORGANIZATIONAL MAINTENANCE
STRUCTURE REPAIR**SHOP PRACTICES****COUNTERSINK FILLERS**

Reference Material

Aircraft Corrosion Control.....	A1-F18AC-SRM-500
Cleaning.....	WP006 00
Stripping.....	WP007 00
Chemical Treatment.....	WP008 00
Priming Procedures	WP011 00
Finish System	WP012 00

Alphabetical Index

Subject	Page No.
General Information	1
Procedures.....	1
Adhesive Application and Filler Installation	2
Adhesive Preparation	2
Curing	2
Surface Preparation	2

Record of Applicable Technical Directives

None

1. **GENERAL INFORMATION.** See figure 1.3. **PROCEDURES.**

2. Countersink fillers (fillers) are used to fill open countersinks in mold line skins, panels, or structure when open countersinks are to be covered by repair doubler or patch. When fabricating fillers, always select correct size and type of material as shown on tables 1 through 3. Fillers may be drilled for fasteners during repair process.

Support Equipment Required

None

Materials Required

Specification or Part Number	Nomenclature
MIL-C-87962, TYPE I	Cleaning Cloth
UU-C-806, TYPE 2, STYLE A, CLASS 1	Waxfree Paper Cup

Materials Required (Continued)

Specification or Part Number	Nomenclature
MIL-G-3866, TYPE 1	Mens Gloves, Cotton Work Gloves
EA934	Adhesive
TT-M-261	Methyl Ethyl
A-A-883, TYPE 1, 1IN	Tape, Pressure Sensitive

4. Surface Preparation.

- Prepare surface(s) per (A1-F18AC-SRM-500, WP006 00, WP007 00, WP008 00, and WP011 00).

NOTE

Wear clean cotton work gloves when handling cleaned surfaces.

- Mask surface 1/2 inch away from area to receive adhesive.

WARNING

Adhesive is toxic. Avoid breathing of vapors. Avoid contact with skin or eyes. Wear gloves and goggles while handling. If eye contact is made, wash immediately with large amount of water. If skin contact is made, wash immediately with soap and water.

NOTE

Mix only amount of material to be used within 40 minutes.

- Adhesive Preparation.** Mix by weight, 100 parts A with 33 parts B. Mix thoroughly to uniform creamy paste.

6. Adhesive Application and Filler Installation.

- Apply 0.010 to 0.015 inch thick layer of adhesive to mating surfaces(s) of both parts.

- Position filler and apply enough pressure to get complete contact.

- Remove masking tape.

WARNING

Methyl ethyl ketone is flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

CAUTION

To avoid contamination of solvent, always pour solvent onto clean cloth. Never dip cloth into solvent.

- Remove excess adhesive and any residual tape adhesive by wiping with clean cloth dampened with methyl ethyl ketone. Wipe surface dry with clean dry cloth before solvent evaporates. Allow surface(s) to air dry for 10 minutes.

- Curing.** Cure adhesive by either method listed below.

- Air cure at room temperature for 5 days.

- Heat cure as below:

- Attach thermocouple to bond line.

- Attach thermocouple to potentiometer.

- Using infrared heat source, maintain surface temperature at bond line of 190°F ±10°F for 1 hour.

- Remove heat source, thermocouple, and potentiometer.

- Apply finish system (A1-F18AC-SRM-500, WP012 00).

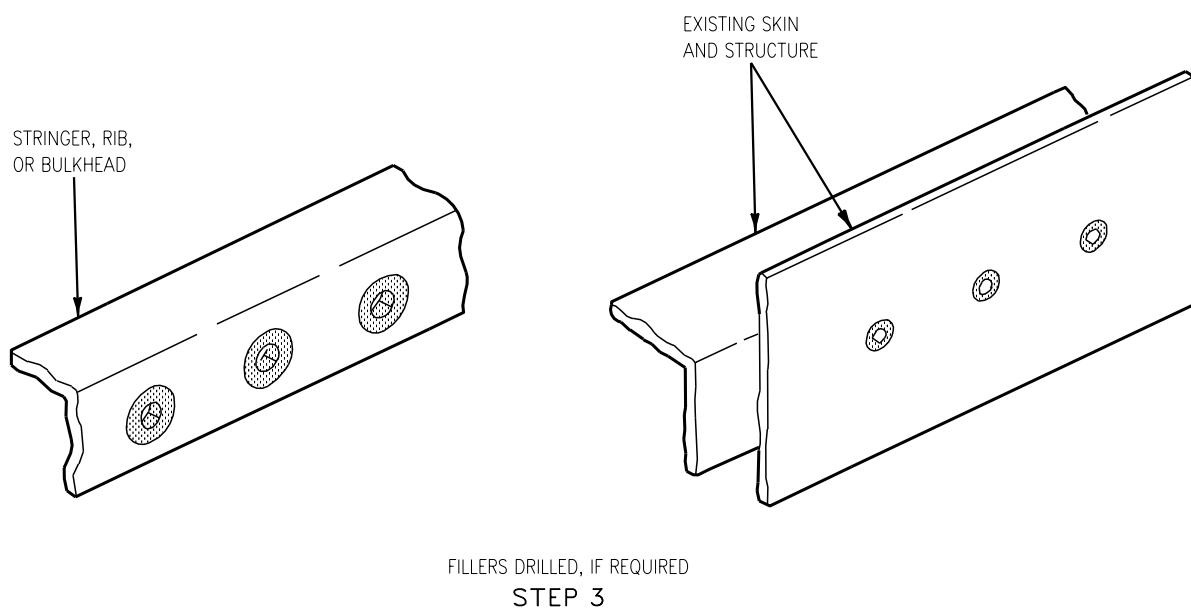
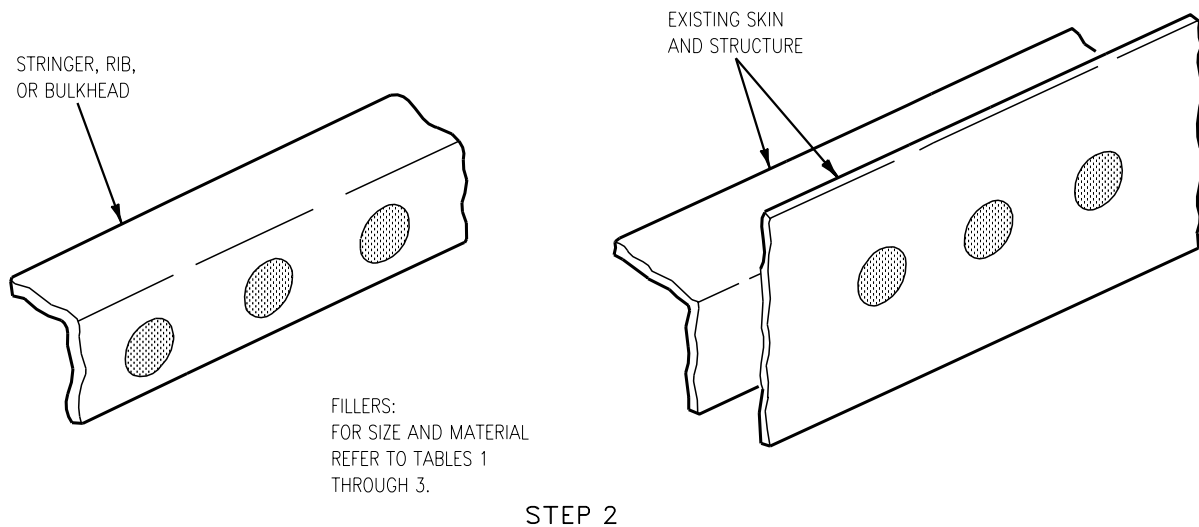
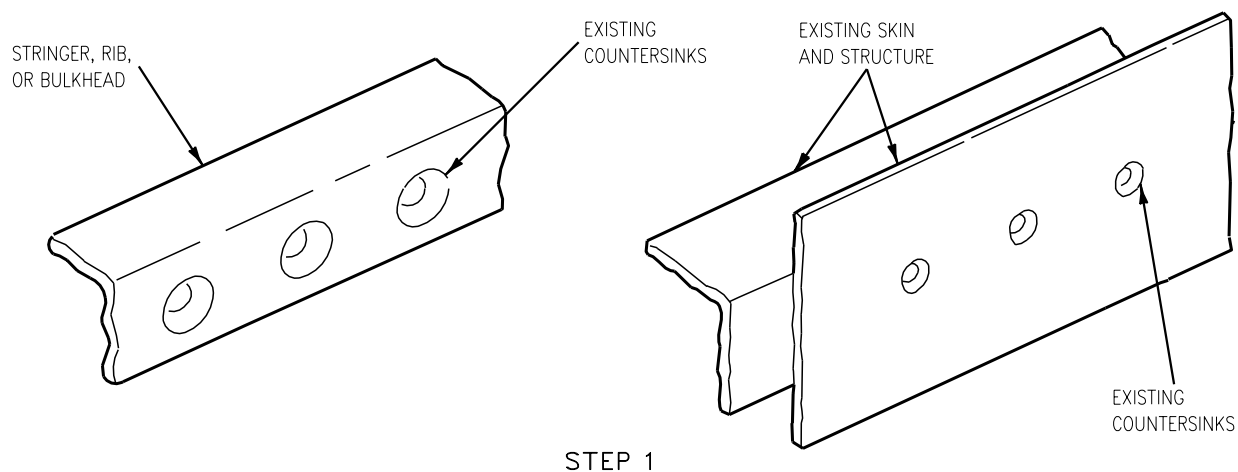


Figure 1. Countersink Fillers (Sheet 1)

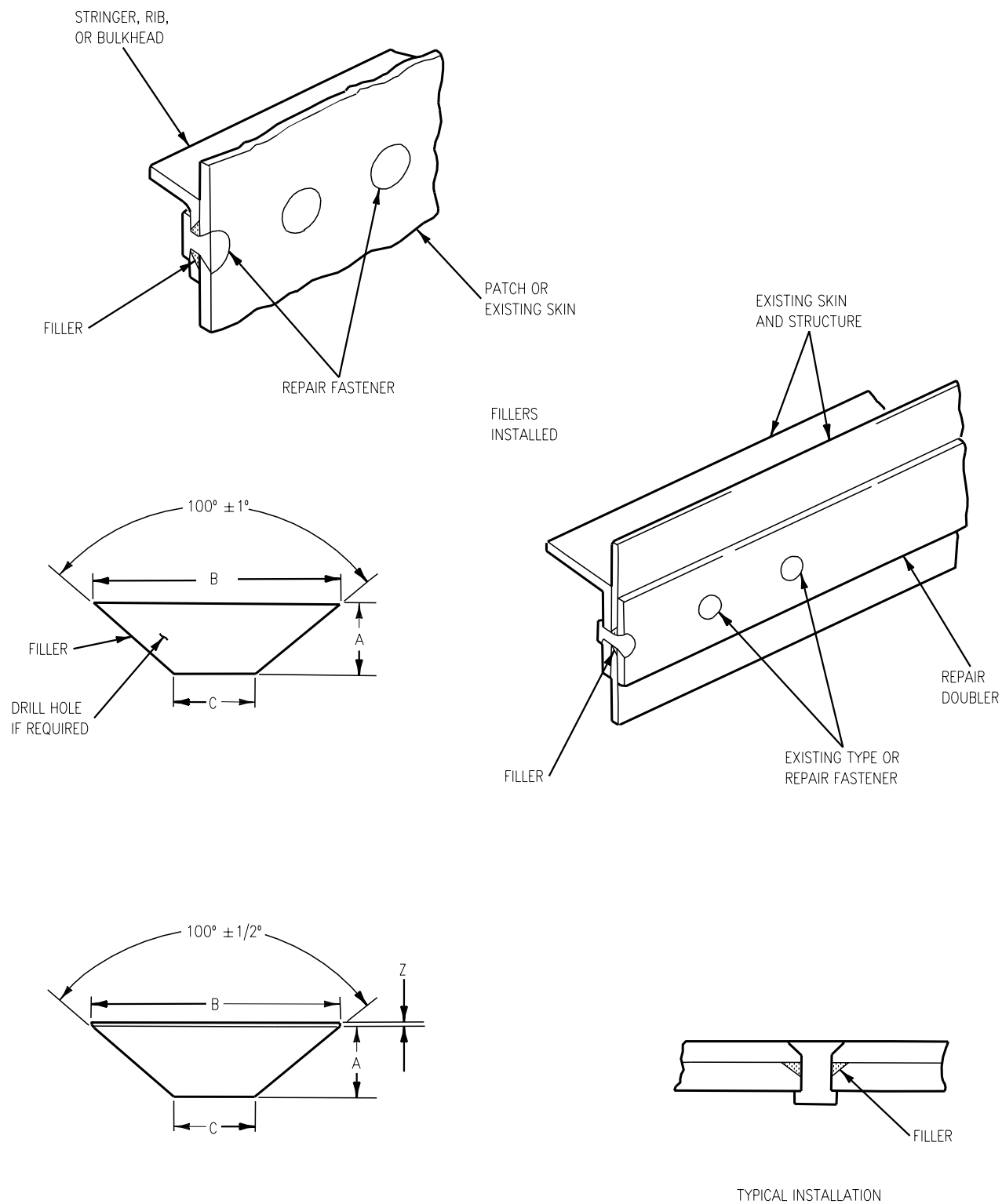


Figure 1. Countersink Fillers (Sheet 2)

Table 1. ALUMINUM COUNTERSINK FILLERS  2





MS20426, NAS1399D, AND ST3M659					
FASTENER SIZE	MATERIAL 	SPECIFICATION	A THICKNESS $\begin{matrix} +0.005 \\ -0.000 \end{matrix}$	B DIA $\begin{matrix} +0.004 \\ -0.004 \end{matrix}$	C DIA $\begin{matrix} +0.003 \\ -0.001 \end{matrix}$
1/8	7075-T6	QQ-A-250/12	0.042	0.225	0.129
5/32	7075-T6	QQ-A-250/12	0.055	0.286	0.160
3/16	7075-T6	QQ-A-250/12	0.070	0.353	0.191
1/4	7075-T6	QQ-A-250/12	0.095	0.476	0.254
NAS1674					
FASTENER SIZE	MATERIAL 	SPECIFICATION	A THICKNESS $\begin{matrix} +0.005 \\ -0.000 \end{matrix}$	B DIA $\begin{matrix} +0.003 \\ -0.003 \end{matrix}$	C DIA $\begin{matrix} +0.0000 \\ -0.0005 \end{matrix}$
5/32	7075-T6	QQ-A-250/12	0.049	0.280	0.1650
3/16	7075-T6	QQ-A-250/12	0.061	0.340	0.1995
1/4	7075-T6	QQ-A-250/12	0.088	0.464	0.2605
NAS1670					
FASTENER SIZE	MATERIAL 	SPECIFICATION	A THICKNESS $\begin{matrix} +0.005 \\ -0.000 \end{matrix}$	B DIA $\begin{matrix} +0.004 \\ -0.003 \end{matrix}$	C DIA $\begin{matrix} +0.0000 \\ -0.0005 \end{matrix}$
5/32	7075-T6	QQ-A-250/12	0.069	0.329	0.1650
3/16	7075-T6	QQ-A-250/12	0.077	0.381	0.1995
1/4	7075-T6	QQ-A-250/12	0.102	0.503	0.2605
5/16	7075-T6	QQ-A-250/12	0.134	0.630	0.3120
3/8	7075-T6	AA-A-250/12	0.160	0.756	0.3750
NAS2705V					
FASTENER SIZE	MATERIAL 	SPECIFICATION	A THICKNESS $\begin{matrix} +0.002 \\ -0.000 \end{matrix}$	B DIA $\begin{matrix} +0.002 \\ -0.000 \end{matrix}$	C DIA $\begin{matrix} +0.0000 \\ -0.0005 \end{matrix}$
5/32	7075-T6	QQ-A-250/12	0.254	0.256	0.1635

Table 2. ALUMINUM COUNTERSINK FILLERS (FAST RIVETS)

4M119						
FASTENER SIZE	MATERIAL	SPECIFICATION	A THICKNESS	B DIA $\begin{matrix} +0.004 \\ -0.004 \end{matrix}$	C DIA $\begin{matrix} +0.003 \\ -0.001 \end{matrix}$	Z LAND AREA
5/32	2024-T4	QQ-A-225/6	0.068	0.332	0.166	0.015
3/16	2024-T4	QQ-A-225/6	0.080	0.385	0.191	0.016
1/4	2024-T4	QQ-A-225/6	0.106	0.507	0.256	0.018
5/16	2024-T4	QQ-A-225/6	0.133	0.635	0.314	0.020
3/8	2024-T4	QQ-A-225/6	0.159	0.762	0.376	0.023
7/16	2024-T4	QQ-A-225/6	0.186	0.890	0.439	0.026

Figure 1. Countersink Fillers (Sheet 3)

Table 3. TITANIUM COUNTERSINK FILLERS

NAS1672					
FASTENER SIZE	MATERIAL	SPECIFICATION	A THICKNESS $\begin{smallmatrix} +0.005 \\ -0.000 \end{smallmatrix}$	B DIA $\begin{smallmatrix} +0.004 \\ -0.003 \end{smallmatrix}$	C DIA $\begin{smallmatrix} +0.0000 \\ -0.0005 \end{smallmatrix}$
5/32	6Al-4V-Ti Anl	MIL-T-9046 TYPE III COMP C	0.069	0.329	0.1650
3/16	6Al-4V-Ti Anl	MIL-T-9046 TYPE III COMP C	0.077	0.381	0.1995
1/4	6Al-4V-Ti Anl	MIL-T-9046 TYPE III COMP C	0.102	0.503	0.2605
5/16	6Al-4V-Ti Anl	MIL-T-9046 TYPE III COMP C	0.134	0.630	0.3120
3/8	6Al-4V-Ti Anl	MIL-T-9046 TYPE III COMP C	0.160	0.756	0.3750
NAS674					
FASTENER SIZE	MATERIAL	SPECIFICATION	A THICKNESS $\begin{smallmatrix} +0.005 \\ -0.000 \end{smallmatrix}$	B DIA $\begin{smallmatrix} +0.004 \\ -0.004 \end{smallmatrix}$	C DIA $\begin{smallmatrix} +0.003 \\ -0.001 \end{smallmatrix}$
1/8	6Al-4V-Ti Anl	MIL-T-9046 TYPE III COMP C	0.042	0.225	0.129
5/32	6Al-4V-Ti Anl	MIL-T-9046 TYPE III COMP C	0.055	0.286	0.159
3/16	6Al-4V-Ti Anl	MIL-T-9046 TYPE III COMP C	0.070	0.353	0.191
1/4	6Al-4V-Ti Anl	MIL-T-9046 TYPE III COMP C	0.095	0.476	0.254

Table 4. CORROSION RESISTANT STEEL (CRES) COUNTERSINK FILLERS


HT4025L					
FASTENER SIZE	MATERIAL	SPECIFICATION	A THICKNESS $\begin{smallmatrix} +0.004 \\ -0.000 \end{smallmatrix}$	B DIA $\begin{smallmatrix} +0.005 \\ -0.004 \end{smallmatrix}$	C DIA $\begin{smallmatrix} +0.0000 \\ -0.0005 \end{smallmatrix}$
3/16	A-286 CRES	AMS 5737	0.080	0.380	0.1895
1/4	A-286 CRES	AMS 5737	0.106	0.501	0.2495
5/16	A-286 CRES	AMS 5737	0.133	0.629	0.3120
3/8	A-286 CRES	AMS 5737	0.160	0.756	0.3745
NAS663 THROUGH NAS666					
FASTENER SIZE	MATERIAL	SPECIFICATION	A THICKNESS $\begin{smallmatrix} +0.0005 \\ -0.0000 \end{smallmatrix}$	B DIA $\begin{smallmatrix} +0.0030 \\ -0.0020 \end{smallmatrix}$	C DIA $\begin{smallmatrix} +0.0000 \\ -0.0005 \end{smallmatrix}$
3/16	A-286 CRES	AMS 5737	0.083	0.3813	0.1895
1/4	A-286 CRES	AMS 5737	0.111	0.5066	0.2495
5/16	A-286 CRES	AMS 5737	0.140	0.6335	0.3120
3/8	A-286 CRES	AMS 5737	0.167	0.7604	0.3745
HT4024L					
FASTENER SIZE	MATERIAL	SPECIFICATION	A THICKNESS $\begin{smallmatrix} +0.004 \\ -0.000 \end{smallmatrix}$	B DIA $\begin{smallmatrix} +0.0030 \\ -0.0000 \end{smallmatrix}$	C DIA $\begin{smallmatrix} +0.0000 \\ -0.0005 \end{smallmatrix}$
3/16	A-286 CRES	AMS 5737	0.048	0.2986	0.1895
1/4	A-286 CRES	AMS 5737	0.062	0.3918	0.2495
5/16	A-286 CRES	AMS 5737	0.071	0.4740	0.3120
3/8	A-286 CRES	AMS 5737	0.081	0.5610	0.3745

Figure 1. Countersink Fillers (Sheet 4)






Table 4. CORROSION RESISTANT STEEL (CRES) COUNTERSINK FILLERS (Continued)

HT4020-()-()A					
FASTENER SIZE	MATERIAL	SPECIFICATION	A THICKNESS $\begin{matrix} +0.0040 \\ -0.0000 \end{matrix}$	B DIA $\begin{matrix} +0.003 \\ -0.002 \end{matrix}$	C DIA $\begin{matrix} +0.0000 \\ -0.0005 \end{matrix}$
3/16	A-286 CRES	AMS 5737	0.0805	0.3785	0.1895
1/4	A-286 CRES	AMS 5737	0.1080	0.5036	0.2495
5/16	A-286 CRES	AMS 5737	0.1350	0.6307	0.3120
3/8	A-286 CRES	AMS 5737	0.1620	0.7576	0.3745

Table 5. CORROSION RESISTANT STEEL (CRES) COUNTERSINK FILLERS (FAST RIVETS)

4M119						
FASTENER SIZE	MATERIAL	SPECIFICATION 	A THICKNESS	B DIA $\begin{matrix} +0.004 \\ -0.004 \end{matrix}$	C DIA $\begin{matrix} +0.003 \\ -0.001 \end{matrix}$	Z LAND AREA
5/32	A-286 CRES	QQ-S-764	0.068	0.332	0.166	0.015
3/16	A-286 CRES	QQ-S-764	0.080	0.385	0.191	0.016
1/4	A-286 CRES	QQ-S-764	0.106	0.507	0.256	0.018
5/16	A-286 CRES	QQ-S-764	0.133	0.635	0.314	0.020
3/8	A-286 CRES	QQ-S-764	0.159	0.762	0.376	0.023
7/16	A-286 CRES	QQ-S-764	0.186	0.890	0.434	0.026

LEGEND

-  ALTERNATE MATERIAL: 2024-T81, QQ-A-250/4.
-  ALTERNATE METHOD, ALUMINUM COUNTERSINK FILLERS.
A. MAKE FILLER FROM MANUFACTURED HEAD OF MS20426 RIVET.
B. BOND FILLERS IN COUNTERSINK HOLES PER PROCEDURES THIS WP.
-  FILLERS
-  ALTERNATE MATERIAL AND SPECIFICATIONS IS 2024-T351 PER QQ-A-200/3.
-  ALTERNATE SPECIFICATIONS IS MIL-S-7720.

18AC-SRM-20-(56-3)39-CAT1

Figure 1. Countersink Fillers (Sheet 5)

ORGANIZATIONAL MAINTENANCE

STRUCTURE REPAIR

SHOP PRACTICES

ALINE-A-DRILL

Reference Material

None

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Record of Applicable Technical Directives

None

1. **DESCRIPTION.** See figure 1.

2. The Aline-A-Drill is used to reduce exit side splintering of graphite epoxy laminate material during drilling operations when backup material is not used.

3. **GENERAL INFORMATION.**

a. A flat flute drill bit (drill bit) is used with the Aline-A-Drill. The dagger tip of drill bit slices through back of graphite epoxy material instead of pushing through like conventional twist drills.

b. The yoke, drill bushing, stops drill bit end wobble and is same size as drill bit.

c. Drill feed rate is limited by an adjustable hydraulic check damper assembly which prevents forceful exit side breakthrough.

d. The Aline-A-Drill keeps drill bit perpendicular to work during drilling operations, making exit perpendicular.

e. Aline-A-Drill speed is approximately 2100 RPM.

4. **PROCEDURES.**

Support Equipment Required

Part Number or Type Designation	Nomenclature
TD5015M-IE	Aline-A-Drill
—	Flat Flute Drill
TD383M-7	Drill Guide
—	Wedgelock

Support Equipment Required (Continued)

Part Number or Type Designation	Nomenclature
TD755R-XX	Drill Bushing, Coolant Type

Materials Required

None

5. Feed Rate Setup. While applying 20 pounds of end load, using shot or sand bag(s) resting on handle of drill motor, adjust hydraulic check damper assembly (6) to get feed rate of 10 to 14 seconds per inch.

6. Drill Bit Alignment.

- Loosen yoke lock screw (12).
- Select correct yoke, drill, bushing (16).
- Install yoke, drill, bushing (16) in yoke (4) using yoke, drill, bushing installation screw (15).
- Install drill bit (14) through drill bushing (15) into drill chuck (13) and tighten drill chuck (13).
- Without moving yoke (4), tighten yoke lock screw (12).
- Loosen drill chuck (13) 1/4-turn with chuck key.
- Drill bit (14) should move freely through yoke drill, bushing (16).
- If binding occurs in yoke drill bushing (16), repeat steps a through e.
- Retighten drill chuck (13) with chuck key.

7. Drill Bit Travel Adjustment.

- Loosen hydraulic check damper arm stop locknut (1) and back off hydraulic check damper arm stop (2) approximately 1/4-inch.
- Turn hydraulic check damper adjustment (7) to zero.

- Loosen yoke lock screw (12).
- Install drill bit (14) and correct drill bushing (16).
- Adjust yoke (4) until end of drill bit (14) is flush with yoke drill bushing (16).
- Without moving yoke (4), tighten yoke lock screw (12).
- Adjust hydraulic check damper arm stop (2) until it is in solid contact with hydraulic check damper arm (3).
- Depress yoke (4) full travel and adjust yoke travel adjustment (9) to desired drill bit travel.

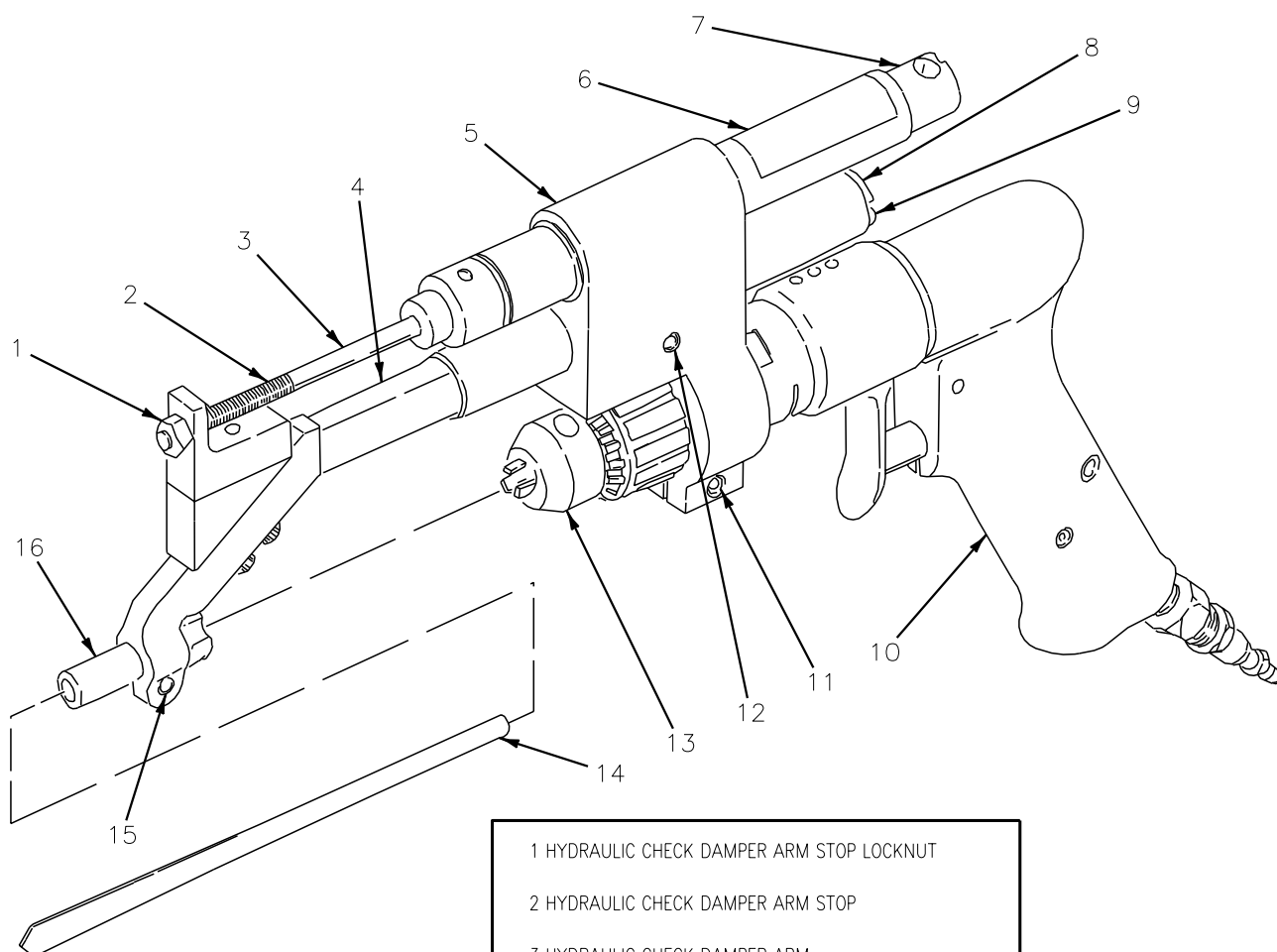
8. Drilling Procedure.

- Center drill guide over location of hole to be drilled.
- Clamp drill guide in position with wedgelock.



Maintain feed rate of paragraph 5 when doing drilling procedure. Excess feed rate will cause splintering on back side of laminate material. Slow feed rate will cause excess drill point force on laminate material causing splintering on back side of laminate material.

- Put yoke drill bushing (16) in drill guide and apply constant pressure with pneumatic drill motor (10) ON until drill bit (14) has traveled its full travel. Drill bit will retract automatically.
- Remove drill guide.
- Position drill guide over location of next hole to be drilled if usable pattern.
- Secure drill guide with wedgelock or through hole previously drilled.
- Repeat steps a. through e. until all holes are drilled.



- 1 HYDRAULIC CHECK DAMPER ARM STOP LOCKNUT
- 2 HYDRAULIC CHECK DAMPER ARM STOP
- 3 HYDRAULIC CHECK DAMPER ARM
- 4 YOKE
- 5 MAIN HOUSING
- 6 HYDRAULIC CHECK DAMPER ASSEMBLY
- 7 HYDRAULIC CHECK DAMPER ADJUSTMENT
- 8 YOKE HOUSING
- 9 YOKE TRAVEL ADJUSTMENT
- 10 PNEUMATIC DRILL MOTOR
- 11 DRILL MOUNT SCREW
- 12 YOKE LOCK SCREW
- 13 DRILL CHUCK
- 14 FLAT FLUTE DRILL BIT
- 15 YOKE, DRILL, BUSHING INSTALLATION SCREW
- 16 YOKE, DRILL BUSHING

Figure 1. Aline-A-Drill

INTERMEDIATE AND DEPOT MAINTENANCE

STRUCTURE REPAIR

SHOP PRACTICES

HOLE PREPARATION AND MACHINING OF HIGH STRENGTH STEEL

Reference Material

Structure Repair, General Information	A1-F18AC-SRM-200
Fasteners	WP004 06
Aircraft Corrosion Control.....	A1-F18AC-SRM-500
Cleaning.....	WP006 00

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Record of Applicable Technical Directives

None

1. HIGH STRENGTH STEELS.

2. High strength steels are required for fabrication of aircraft parts. Steels are made in variety of forms. Correct procedures for working with these materials are required and will eliminate or minimize overheating, cracking, high residual stresses, and other metallurgical changes.

3. GENERAL INFORMATION.

a. Allow enough material to remain for any finishing operations specified.

b. Make sure both cutting tool and part(s) are secured to prevent tool chatter, chipped cutting edges, and rough edges.

c. During cutting tool operation, immediately replace tools that chatter or squeal, have chipped

cutting edge(s), are discolored, or show evidence of incorrect cutting.

d. Make sure enough cutting fluid gets to cutting tool and part(s).

e. Before each use, inspect tool cutting edges for chips, discoloration, or wear.

f. Never use dry pass, spark out, during grinding of any heat treated or chromium plated steel surface.

4. SAFETY PRECAUTIONS.

a. Eye protection is required during all tool cutting operations.

b. Protective clothing, as required, shall be used during all tool cutting operations.

c. Make sure all general shop safety is followed during tool cutting operations.

5. HOLE PREPARATION. See figure 1.

Support Equipment Required

Part Number or Type Designation	Nomenclature
—	Hones, Single Stone Head, Brass Shoes or Wipers
—	Hones, Multi Stone Head, Brass Shoes or Wipers
—	Boring Bars, Carbide Cutting Edges, Commercial
—	Countersinks, HSS, Commercial
—	Countersinks, Cobalt, Commercial
—	Countersinks, Carbide, Commercial
TFIM 25.121	Reamers, Carbide
TFIM 25.0212 Thru	Drills
TFIM 25.0218	
—	Positive Gear Fed Portable Drilling Unit, Commercial

Support Equipment Required (Continued)

Part Number or Type Designation	Nomenclature
—	Stationary Equipment, Power Fed
—	High Torque Drill Motor
—	Twist Drills, Cobalt
—	Twist Drills, Carbide
—	Countersink, 100°, Carbide

Materials Required

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
ISOPAR M	Cutting Fluid, General Purpose, Water Base
MMS-611, MACCO 472MPA No. 653	Heavy Duty Emulsifiable Oils
D 1153	Methyl Isobutyl Ketone

6. **REQUIREMENTS.** Holes in high strength steels heat treated to 180,000 psi or higher, shall be avoided when practical. However, when holes are to be added or enlarged after heat treatment, this work package shall be the guide for equipment, cutting tools, speeds, feeds, and coolant.

a. Drilling and reaming speeds shall not exceed maximums shown in figure 1, tables 1 through 3.

b. All holes made in high strength steels heat treated to 220,000 psi and higher, shall be honed to remove minimum of 0.0015 inch of material from all surfaces, 0.003 inch minimum increase in diameter.

NOTE

Holes that are honed do not require temper etch inspection.

c. Boring shall be accomplished using bars having carbide cutting edges and at cutting speeds

not exceeding maximum speeds for reaming given in figure 1, table 2. If hole is not honed, temper etch, as required, use local methods and 10 percent ammonium persulfate solution.

d. Use cutting fluid for all drilling, reaming, boring, or countersinking operations.

e. Use power fed stationary equipment, whenever possible, for all machining of holes in high strength steels heat treated to 200,000 psi or higher.

f. When required, high strength steel heat treated to 300,000 psi may be drilled, reamed, countersunk, and bored using hard tooling and heavy duty positive gear fed portable drilling units. All restrictions applicable to stationary hole cutting methods shall apply except heavy spray mist Isopar M shall be used as coolant.

g. Free hand, without positive gear fed units, drilling, reaming, and countersinking of high strength steel heat treated up to 200,000 psi is allowed. Speeds shall not exceed one half speeds allowed for hole cutting using stationary shop equipment. A flood or heavy spray mist of Isopar M shall be used as coolant during all drilling, reaming, and countersinking operations.

h. Holes made with stationary or positive gear fed portable equipment in high strength steel, heat treated to 200,000 psi and higher, shall be honed to remove minimum 0.003 inch material from hole diameter.

i. All new or reworked holes made using free hand procedures shall be honed to remove minimum of 0.005 inch of material from hole diameter.

7. DRILLING AND REAMING USING STATIONARY EQUIPMENT.

a. Drill required holes undersized to allow for minimum 0.010 inch material to be removed from hole diameter by reaming. If reamed holes are to be honed per paragraph 6, step h, allow enough stock for honing during final reaming operation.

b. After final reaming, remove minimum of 0.003 inch of stock from hole diameter by honing.

8. BORING.

a. Bore holes to required diameters. Minimum of 0.010 of stock should be removed from hole

diameter during each pass. Allow enough stock for honing during final boring pass.

b. After final boring pass, remove minimum 0.003 inch of stock from hole diameter by honing.

9. COUNTERSINKING AND DEBURRING USING STATIONARY EQUIPMENT.

a. Countersink holes to required depth or diameter.

b. Deburr all noncountersink hole edges by breaking with 100 degree countersink to depth of 0.010 to 0.015 inch. For deburring, use same parameters as for countersinking except coolant is not required.

10. DRILLING, REAMING, BORING, AND HONING HOLES USING POSITIVE FEED EQUIPMENT.

a. Use heavy duty positive feed drilling units and hard tooling for drilling, reaming, boring, and countersinking of holes in all steel parts heat treated above 180,000 psi. Heavy spray mist of Isopar M coolant is required.

b. After final reaming or boring operation, hone all holes to remove minimum of 0.003 inch of stock from diameter.

c. Deburr all noncountersink hole edges by breaking with 100 degree carbide countersink to depth of 0.010 to 0.015 inch. Do not exceed drilling speeds when breaking hole edges, see figure 1, table 2. Free hand methods using slow speed drill motors may be used with or without coolant.

11. FREE-HAND DRILLING, REAMING, HONING, COUNTERSINKING, AND DEBURRING OF HOLES.

a. Free hand, without positive or assisted feed units, drilling and reaming holes in steel parts heat treated up to 200,000 psi, select high torque drill motors having maximum speeds that will not exceed 1/2 maximum drilling and reaming speeds allowed in figure 1, tables 1 and 3.

b. Typical sequence using selected drill motor and substeps below:

(1) Drill 0.156 or 0.187 inch diameter pilot hole.

(2) Open pilot hole 0.016 inch diameter increments by reaming with piloted carbide tipped reamers until hole diameter is 0.005 inch under final required size.

(3) As reamer sizes increase, slower speed drill motors may be required to stay below maximum allowed speeds.

(4) Use flood or heavy spray mist of Isopar M coolant for all drilling and reaming.

c. After final reaming pass, remove additional 0.005 inch of stock from hole diameter by honing.

d. When required, countersink holes using carbide cutters per paragraph 9 and Isopar M coolant.

e. Deburr all noncountersink hole edges by breaking with 100 degree carbide countersink to depths of 0.010 to 0.015 inch. Do not exceed drilling speeds shown in figure 1, table 2. Use of coolant during breaking of hole edges is not required.

12. General.

a. Apply enough force to keep drill cutting continuously.

b. Excessive force may bow or bend drill causing elongated holes and tool breakage. Lack of force will dull drill quickly.

c. Use shortest drill with shortest flutes possible.

d. Undersize pilot holes; #40 or 0.125 inch dia. may be used to reduce force required for feeding.

e. When reaming, countersinking, and counterboring, force required to maintain constant feed rate normally will be less than required for drilling.

f. When drill or reamer exits on back side of structure being drilled, slowly rotate drill motor clockwise while pulling tool back through hole. Do not stop or reverse rotation when removing tool from hole.

g. Drill motors having wobbly chucks, loose and worn bearings, or worn gears causing vibration/uneven feed rates shall not be used.

h. All drill motors shall be marked with maximum speed rate.

13. Requirements.

a. Drill motors shall not be triggered and air hoses shall not be 'C'-Clamped to reduce drilling speeds below maximum allowed. Always use drill motors with rated speeds below specified maximum limits.

b. Temperatures at periphery of hole(s) during drilling shall be kept to minimum so not to cause;

(1) Discoloration of bare metal.

(2) Discoloration of painted surfaces.

(3) Excessive coolant vaporization.

c. To get best possible hole tolerance, hole finish, and to prevent tool breakage, always support thin gage material on exit side of hole, if possible.

d. Drilling and reaming holes through combination of dissimilar alloys, use feed and speed requirements of harder material. Drilling or reaming direction shall be from side of harder material.

e. Frequent drill and reamer withdrawal and use of lubricants may be required when working from side of softer material.

f. When using step drills, first step must drill completely through material before final step of drill begins cutting.

g. Tool marks at 45 degree angle or less, with axis of hole are not acceptable.

h. Paper and synthetic nonwoven wipers shall not be used for final cleaning of bare or painted surfaces of aircraft.

i. When drilling into parts near electrical wires or equipment, fluid lines, control cables, or inner structure, drill stops shall be used. Drill stop should be adjusted to limit drill point to 1/16-inch penetration beyond sheet or part.

14. Hole Quality.

a. Visual Inspection:

(1) Discoloration of bare/painted surfaces around periphery of hole(s) is indication of over heating, submit request for engineering disposition.

(2) Burrs around holes shall be removed.

(3) Hole finish should be RHR 125 or better.

(4) Holes or countersinks shall meet following;

(5) No tool marks or scratches allowed 45 degrees or less with hole axis.

(6) Make sure tool marks or scratches do not cause surface finish of hole(s) or countersink(s) to exceed specified limits for specific fastener installation.

(7) Magnetic particle inspection / penetrant inspection is recommended for martensitic steel or stainless steel that has been ground.

NOTE

Surfaces with tool marks or scratches may be reworked to pass visual and dimensional inspection.

(8) Tool marks shall not exceed 0.001 inch.

b. Dimensional Inspection:

(1) Make sure hole location and edge distance are correct.

(2) All holes shall be drilled normal to surface, as required.

(3) All holes shall be drilled within minimum or maximum specifications.

(4) All countersinks shall have correct diameter, included angles, alignment, or intersection radii; allowing correct seating of fastener head within flushness and gap ranges specified in specific procedure work package.

c. Inspection Frequencies:

(1) Inspect all hole(s) when cold worked, during interference fastener removal/installation, or when specifications require 100 percent inspection.

(2) When hole(s) require tolerance of 0.003 inch or less, inspect 100 percent.

(3) If hole pattern is four or less holes inspect 100 percent.

(4) If hole pattern is 4 to 30 holes, inspect 3 randomly selected holes in pattern.

(5) If hole pattern is over 30 holes inspect 10 percent of holes randomly selected.

(6) If any hole is rejected, inspect all remaining holes in pattern.

(7) Holes having total diametrical tolerance greater than 0.003 inch, inspection to reasonably make sure visual and dimensional acceptance criteria specified are being met and maintained.

d. Hole shall be normal to surface upon which fastener head will seat.

e. For head gap, tilt, and other specific criteria (WP004 06).

f. Cylindrical holes and countersinks shall not be out of round or tapered to extent high and low limits of hole tolerance is exceeded.

g. Concentricity of hole, countersink, and radius shall meet specifications of fastener(s) to be installed.

h. Hole finish shall meet requirements of specific procedure work package.

i. Before deburring, burrs and material surrounding holes shall be inspected for discoloration caused by excess temperature due to excess speed/dull drill. If discoloration can not be removed with solvent, holes shall be rejected and submitted for engineering disposition.

j. Primed and painted surfaces surrounding holes shall be examined for discoloration due to excessive temperatures. If discoloration can not be removed with solvent, holes shall be rejected and submitted for engineering disposition.

15. Hole Cutting Tools.

a. Steel alloys shall be drilled using 8 percent cobalt H.S.S. or carbide tools.

b. Cutting tools that are bent, damaged, dull, or incorrectly sharpened shall not be used.

c. Tools having smeared metal bonded or welded to margins shall not be used for making finish holes.

d. Countersink, counterbore, spotface, and reamer pilot diameters shall be 0.001 to 0.004 inch

smaller than diameter of hole to prevent tool chatter marks and out of tolerance conditions.

16. Lubricants.

a. Approved lubricant shall be used, as required, see figure 1, table 4.

b. Mix ratios are, water/lubricant, as below;

- Bio-cool 500NF 20 to 1.
- MMS611 and Immunol #1809 30 to 1.

c. Mixing lubricants or use of deteriorated or contaminated lubricants is prohibited.

d. Spray mist applied Isopar M, containing 1 percent Butyl Cellosolve, may be used for all assembly drilling of bare and primed parts and assemblies, assemblies having faying surface sealed areas, and assemblies which cannot be separated for cleaning. When Isopar M is correctly spray mist applied, cleaning of parts and assemblies is not required by other applicable cleaning requirements for sealing, bonding, or painting.

e. When allowed, per figure 1, table 4, cetyl alcohol, in stick form, applied to tool before use, may be used as lubricant in areas where other lubricants are not practical. Disassembly and cleaning of parts is not required after use of cetyl alcohol if applied per this step.

f. When water based coolants, applied either by flood or mist are used for assembly drilling, assemblies shall be disassembled and solvent cleaned per (A1-F18AC-SRM-500, WP006 00) to remove all traces of lubricant.

g. Bonded structures and assemblies that can not be separated for cleaning, water based coolants can be used only by dipping cutting tool into coolant and allowing excess coolant to drip off before use.

17. Tool Feed and Speed.

a. Drill shall not be allowed to dwell on material without cutting. Force shall be applied to drill immediately on contact with material being drilled.

b. Drill speeds in relation to hole size and material, shall be per figure 1, table 5.

c. Speed for reaming, countersinking, and counterboring shall be 1/3 to 1/2 of maximum

drilling speeds specified in figure 1, table 5 for drilling.

18. Hole Alignment, Gaps, and Preload.

a. All parts shall be securely fastened together before drilling/reaming through more than one thickness. There are no exceptions allowed on joints that can not be disassembled for cleaning and deburring.

b. All gaps that remain after finger pressure has been applied shall be treated as follows:

(1) Gaps between mating surfaces, caused by surface steps resulting from allowed manufacture conditions such as machining mismatch, chem-milling steps, and tolerance build-up, see figure 2, will be acceptable to shanks of first two fasteners immediately near that step. However, fastener(s) shall not be end fastener and magnitude of gap does not exceed values specified in figure 1, table 6. Exception to this is no gap shall be allowed in integral fuel tank boundaries or pressurized areas.

(2) Other chronic gap conditions resulting from designed gaps shall be submitted to engineering for disposition.

c. To prevent preload between mating parts, all gaps which are not allowed shall be corrected per engineering disposition.

d. Before drilling fastener holes mold line skins shall be placed on structure to be trimmed/aligned. This trimming/aligning is required to:

(1) Maintain minimum specified fastener hole edge distances.

(2) Meet butt gap tolerances specified by specific procedure work package or engineering disposition.

(3) If substeps (1) and (2) above can not be met, request engineering disposition before completing incorporation of fastener pattern.

19. Deburring.

a. Holes shall be free of dirt or contaminates that may be imbedded into surface during deburring (A1-F18AC-SRM-500, WP006 00), Solvent Cleaning.

b. Fastener holes may be deburred with H.S.S., cobalt, or carbide rotary deburring tools, speeds shall not exceed 250 S.F.M.

c. Deburr hole(s) using light pressure, excess pressure will cause tool to dig or grab.

d. Do not use defective tools. Defective tools may cause out-of-tolerance holes.

20. **MACHINING AND GRINDING.** See figure 3.

21. **MACHINING.**

a. High strength steel, exceeding 180,000 psi, shall be machined using parameters in figure 3, tables 1 through 5.

b. Machine setup shall be as rigid as possible. Items included in rigid setup are; arbor support bearing adjustment or positioning, overarm support(s) adjustment or positioning, clamping of part(s) in fixture(s), and clamping of fixture(s) on machine bed(s).

c. Emulsifiable oils shall be applied either by spray mist or flood. For flood applications, mix one part emulsifiable oil with 10 to 20 parts of water. For spray mist application use 30 to 1 ratio.

d. Cutting oils shall be applied only by flood. These oils may be mixed with 10 w paraffin based oil to provide viscosity ranging from 75 to 125 saybolt universal seconds (SUS) at 100° F. Mix ratio is per manufacturing option.

e. Only face milling using carbide inserts may be done without using coolants. All other machining methods shall be done using coolants or fluids recommended in figure 3, tables 1 through 5.

22. **GRINDING.**

a. Using grinders equipped with aluminum oxide wheels and not exceeding speeds allowed in figure 3, tables 6 and 7.

b. Speeds and feeds used in grinding methods shall not exceed those allowed in figure 3, tables 6 and 7.

c. Martensitic steel, exceeding 180,000 psi, with surfaces which are conventionally surface ground, figure 3, table 6, shall be grit blasted, as required, to

pass temper etch inspection and shot peened to provide 200 percent coverage. No martensitic stainless steel surface shall be surface ground using conventional method of figure 3, table 6.

d. Martensitic steel and martensitic stainless steel surfaces ground by any method shown in figure 3, table 6, other than conventional surface grinding, need not be shot peened unless specifically required by that method. However, all martensitic steel, exceeding 180,000 psi, with surfaces which are ground by any method(s) shown in figure 3, table 6, must be temper etched using local method and 10 percent ammonium persulfate solution.

e. Heavy duty emulsifiable oil is recommended for conventional surface grinding and allowed for all other grinding methods except low stress surface grinding. Heavy duty oils are recommended for all other grinding methods shown in figure 3, tables 6 and 7 except conventional surface grinding.

f. Coolants shall flood surface during all grinding passes.

g. Grinding wheels shall be kept dressed, sharp, to prevent load up which causes smearing and glazing of metal.

h. Plunge grinding is not recommended, but allowed, if part geometry or grinding method requires it. When plunge grinding is required, complete wheel sparkout is required after each increment of downfeed or infeed. Downfeed or infeed increments shall not exceed figure 3, tables 6 and 7 allowables.

i. Parameters shown in figure 3, tables 6 and 7 are not applicable for grinding threads on heat treated steel surfaces. Thread grinding may be accomplished using normal shop procedures and substeps below:

(1) Wheel speeds below 5,000 SFM.

(2) Work speeds between 4 and 6 SFM.

(3) Two roughing passes plus one 0.005 clean-up pass.

(4) R or S hardness wheel.

(5) Use sulfo-chlorinated grinding oil for all grinding passes.

TABLE 1.PARAMETERS FOR POWER FEED DRILLING OF HIGH STRENGTH STEELS WITH COBALT DRILLS AND COOLANT

BASE MATERIAL	STRENGTH LEVELS (KSI)	APPROXIMATE HARDNESS LEVELS (R _C)	MAXIMUM TOOL SPEED (SFM)	RECOMMENDED FEED RATES (INCH/REVOLUTION)						
				NOMINAL HOLE DIAMETER IN (INCHES)						
				1/8	1/4	1/2	3/4	1	1 1/2	2
4130, 4140, 4340	180 - 200	40 - 43	40	0.002	0.003	0.004	0.005	0.006	0.006	0.008
4330V, 4340, 300M, D6AC	200 - 220	43 - 46	35	0.002	0.003	0.004	0.004	0.004	0.004	0.004
	220 - 240	46 - 48	30	0.001	0.002	0.003	0.004	0.004	0.004	0.004
	240 - 260	48 - 50	25	0.001	0.002	0.003	0.003	0.004	0.004	0.004
	260 - 280	50 - 52	20	N.R.	0.001	0.002	0.002	0.003	0.003	0.004
	280 - 300	52 - 55	20	N.R.	0.001	0.001	0.0015	0.0015	0.002	0.002
HP-9-4-30	220 - 240	48 - 50	20	0.001	0.002	0.003	0.003	0.004	0.004	0.004
AF 1410	235 MIN.	47 - 50	20	0.001	0.002	0.002	0.003	0.003	0.004	0.004
NOTE: RECOMMENDED FEED RATES ARE NOT MANDATORY.										

TABLE 2.PARAMETERS FOR POWER FEED DRILLING OF HIGH STRENGTH STEELS WITH CARBIDE DRILLS AND COOLANT

BASE MATERIAL	STRENGTH LEVELS (KSI)	APPROXIMATE HARDNESS LEVELS (R _C)	MAXIMUM TOOL SPEED (SFM)	RECOMMENDED FEED RATES (INCH/REVOLUTION)						
				NOMINAL HOLE DIAMETER IN (INCHES)						
				1/8	1/4	1/2	3/4	1	1 1/2	2
4130, 4140, 4340	180 - 200	40 - 43	80	0.001	0.002	0.003	0.004	0.004	0.005	0.006
4330V, 4340, 300M, D6AC	200 - 220	43 - 46	75	0.001	0.001	0.002	0.003	0.004	0.004	0.005
	220 - 240	46 - 48	60	0.001	0.001	0.002	0.003	0.004	0.004	0.005
	240 - 260	48 - 50	50	0.0005	0.001	0.002	0.002	0.003	0.003	0.004
	260 - 280	50 - 52	40	0.0005	0.001	0.0015	0.002	0.0025	0.003	0.003
	280 - 300	52 - 55	40	0.0005	0.001	0.001	0.0015	0.0015	0.002	0.002
HP-9-4-30	220 - 240	48 - 50	40	0.0005	0.001	0.0015	0.002	0.0025	0.003	0.003
AF 1410	235 MIN.	47 - 50	40	0.0005	0.001	0.001	0.0015	0.0015	0.002	0.002
NOTE: RECOMMENDED FEED RATES ARE NOT MANDATORY.										

TABLE 3. PARAMETERS FOR POWER FEED REAMING OF HIGH STRENGTH STEELS WITH CARBIDE REAMERS AND COOLANT

BASE MATERIAL	STRENGTH LEVELS (KSI)	APPROXIMATE HARDNESS LEVELS (R _C)	MAXIMUM TOOL SPEED (SFM)	RECOMMENDED FEED RATES (INCH/REVOLUTION)						
				NOMINAL HOLE DIAMETER IN (INCHES)						
				1/8	1/4	1/2	3/4	1	1 1/2	2
4130, 4140, 4340	180 - 200	40 - 43	30	0.004	0.006	0.007	0.008	0.010	0.011	0.012
4330V, 4340, 300M, D6AC	200 - 220	43 - 46	30	0.003	0.005	0.006	0.007	0.008	0.009	0.010
	220 - 240	46 - 48	25	0.003	0.005	0.006	0.007	0.008	0.009	0.010
	240 - 260	48 - 50	25	0.003	0.004	0.005	0.006	0.006	0.007	0.008
	260 - 280	50 - 52	20	0.002	0.003	0.004	0.005	0.005	0.006	0.006
	280 - 300	52 - 55	20	0.002	0.002	0.003	0.004	0.004	0.004	0.004
HP-9-4-30	220 - 240	48 - 50	20	0.002	0.002	0.003	0.004	0.004	0.004	0.004
AF 1410	235 MIN.	47 - 50	20	0.002	0.002	0.003	0.004	0.004	0.004	0.004
NOTE: RECOMMENDED FEED RATES ARE NOT MANDATORY.										

Figure 1. Hole Preparation Parameters (Sheet 1)

TABLE 4. LUBRICATION CHART FOR STEEL ALLOYS HEAT TREATED TO LESS THAN 180 KSI

LUBRICATION TYPE	APPLICATION METHOD
DRY ISOPAR M MMS611 IMMUNOL #1809 BIO-COOL 500NF CETYL ALCOHOL	NONE MIST MIST OR FLOOD MIST OR FLOOD MIST OR FLOOD STICK

TABLE 5. MAXIMUM SPEEDS FOR FREE-HAND ASSEMBLY DRILLING OF ALLOYS HEAT TREATED TO LESS THAN 180 KSI

MATERIAL TO BE DRILLED	TYPE DRILL T.F.I.M.	MAXIMUM							
		#40	1/8	3/16	1/4	5/16	3/8	7/16	1/2
STEEL AL-LOYS	TYPE U-Z	1000	1000	500	500	300	250	200	150
NOTE: FREE-HAND ASSEMBLY DRILLING/REAMING OF HOLES LARGER THAN 1/4-INCH IN STEEL IS NOT RECOMMENDED WITHOUT DRILLING AIDS.									

TABLE 6. ALLOWABLE GAPS TO FASTENER SHANKS (SEE PARAGRAPH 18)

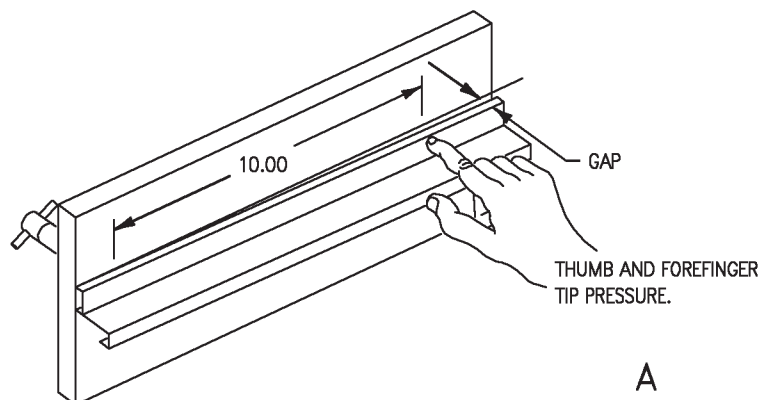
NOMINAL FASTENER DIA. (INCH)	ALLOWABLE GAP (INCH)
3/32	0.010
1/8	0.011
5/32	0.013
3/16	0.015
1/4	0.018
5/16 AND LARGER	0.020

LEGEND

RC - ROCKWELL C SCALE HARDNESS

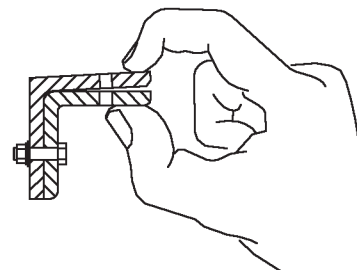
KSI - 1,000 POUNDS PER SQUARE INCH (STRENGTH LEVEL)

SFM - SURFACE FEET PER MINUTE (SPEED)

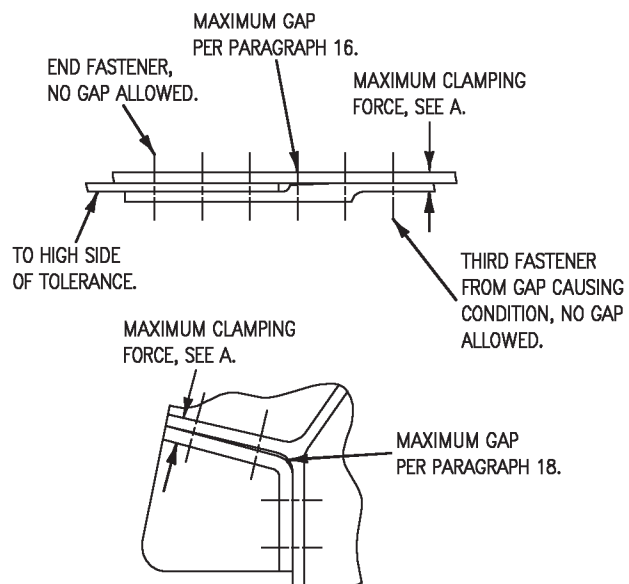
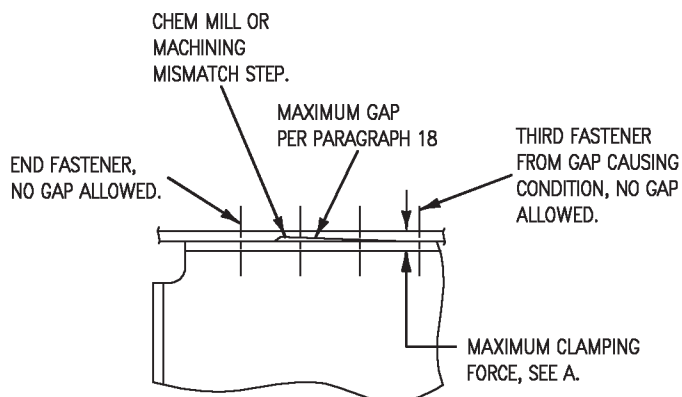


A

ALL GAPS WHICH CANNOT BE CLOSED BY THUMB AND FOREFINGER TIP PRESSURE ONLY, USING ONE OR BOTH HANDS, ARE UNACCEPTABLE.



B



C



Figure 2. Allowable Gap

TABLE 1. FACE MILLING PARAMETERS FOR HIGH STRENGTH STEELS

ALLOYS	HEAT TREAT STRENGTH LEVELS (PSI X 1000)	APPROXIMATE HARDNESS LEVEL (R _C)	CARBIDE TOOLS		HSS TOOLS	
			MAXIMUM SPEEDS (S.F.M.)	RECOMMENDED FEEDS (I.P.T.)	MAXIMUM SPEEDS (S.F.M.)	RECOMMENDED FEEDS (I.P.T.)
4130, 4140, 4340	180 - 200	40 - 43	230	0.004 - 0.006	50	0.003 - 0.005
4340, 4330V (MOD)	200 - 220	43 - 46	200	0.004 - 0.006	45	0.003 - 0.005
4330V (MOD) D6AC	220 - 240	46 - 48 1/2	175	0.003 - 0.005	35	0.002 - 0.004
D6AC	240 - 260	48 1/2 - 50 1/2	160	0.003 - 0.005	30	0.001 - 0.003
AF 1410	235 MIN.	47 - 50	160	0.003 - 0.005	30	0.001 - 0.003
300M	280 - 300	53 - 55	100	0.001 - 0.003	NOT ALLOWED	
HP9-4-30	220 - 240	44 - 49	175	0.003 - 0.005	35	0.002 - 0.004
NOTE: RECOMMENDED CUTTING FLUIDS: A. HSS - HEAVY DUTY OILS. B. CARBIDE - DRY OR HEAVY DUTY EMULSIFIABLE OILS.						

TABLE 2. SINGLE POINT TURNING PARAMETERS FOR HIGH STRENGTH STEELS

ALLOYS	HEAT TREAT STRENGTH LEVELS (PSI X 1000)	APPROXIMATE HARDNESS LEVEL (R _C)	CARBIDE TOOLS		HSS TOOLS	
			MAXIMUM SPEEDS (S.F.M.)	RECOMMENDED FEEDS (I.P.T.)	MAXIMUM SPEEDS (S.F.M.)	RECOMMENDED FEEDS (I.P.T.)
4130, 4140, 4340	180 - 200	40 - 43	280	0.005 - 0.015	55	0.004 - 0.010
4340, 4330V (MOD)	200 - 220	43 - 46	215	0.004 - 0.010	40	0.004 - 0.010
4330V (MOD) D6AC	220 - 240	46 - 48 1/2	200	0.004 - 0.010	30	0.004 - 0.010
D6AC	240 - 260	48 1/2 - 50 1/2	150	0.004 - 0.008	25	0.004 - 0.008
AF 1410	235 MIN.	47 - 50	150	0.004 - 0.008	25	0.004 - 0.008
300M	280 - 300	53 - 55	90	0.003 - 0.007	15	0.001 - 0.003
HP9-4-30	220 - 240	44 - 49	200	0.004 - 0.010	30	0.004 - 0.010
NOTE: RECOMMENDED CUTTING FLUIDS: A. HSS - HEAVY DUTY OILS. B. CARBIDE - DRY OR HEAVY DUTY EMULSIFIABLE OILS.						

TABLE 3. SLAB MILLING PARAMETERS FOR HIGH STRENGTH STEELS

ALLOYS	HEAT TREAT STRENGTH LEVELS (PSI X 1000)	APPROXIMATE HARDNESS LEVEL (R _C)	HSS TOOLS	
			MAXIMUM SPEEDS (S.F.M.)	RECOMMENDED FEEDS (I.P.T.)
4130, 4140, 4340	180 - 200	40-43	65	0.003 - 0.005
4340, 4330v (MOD)	200 - 220	43 - 46	50	0.003 - 0.005
4330V (MOD) D6AC	220 - 240	46 - 48 1/2	40	0.002 - 0.004
D6AC	240 - 260	48 1/2 - 50 1/2	30	0.002 - 0.004
AF 1410	235 MIN.	47 - 50	30	0.002 - 0.004
300M	280 - 300	53 - 55	NOT ALLOWED	
HP9-4-30	220 - 240	44 - 49	40	0.002 - 0.004
NOTE: RECOMMENDED CUTTING FLUIDS: HSS - DRY OR HEAVY DUTY EMULSIFIABLE OILS.				

TABLE 4. PERIPHERAL END MILLING PARAMETERS FOR HIGH STRENGTH STEELS

ALLOYS	HEAT TREAT STRENGTH LEVELS (PSI X 1000)	APPROXIMATE HARDNESS LEVEL (R _C)	CARBIDE TOOLS		HSS TOOLS	
			MAXIMUM SPEEDS (S.F.M.)	RECOMMENDED FEEDS (I.P.T.)	MAXIMUM SPEEDS (S.F.M.)	RECOMMENDED FEEDS (I.P.T.)
4130, 4140, 4340	180 - 200	40 - 43	195	0.001 - 0.004	60	0.0005 - 0.003
4340, 4330V (MOD)	200 - 220	43 - 46	150	0.001 - 0.003	45	0.0005 - 0.002
4330V (MOD) D6AC	220 - 240	46 - 48 1/2	125	0.0005 - 0.002	40	0.0005 - 0.002
D6AC	240 - 260	48 1/2 - 50 1/2	85	0.0005 - 0.002	35	0.0005 - 0.002
AF 1410	235 MIN.	47 - 50	85	0.0005 - 0.002	35	0.0005 - 0.002
300M	280 - 300	53 - 55	65	0.0005 - 0.001	NOT ALLOWED	
HP9-4-30	220 - 240	44 - 49	125	0.0005 - 0.002	50	0.0005 - 0.002
NOTE: RECOMMENDED CUTTING FLUIDS: A. HSS - HEAVY DUTY EMULSIFIABLE OIL. B. CARBIDE - DRY OR HEAVY DUTY EMULSIFIABLE OILS.						

TABLE 5. PARAMETERS FOR ARBOR MOUNTED SIDE, SLOTING, ANGLE, AND FORM CUTTERS FOR HIGH STRENGTH STEELS

ALLOYS	HEAT TREAT STRENGTH LEVELS (PSI X 1000)	APPROXIMATE HARDNESS LEVEL (R _C)	CARBIDE TOOLS		HSS TOOLS	
			MAXIMUM SPEEDS (S.F.M.)	RECOMMENDED FEEDS (I.P.T.)	MAXIMUM SPEEDS (S.F.M.)	RECOMMENDED FEEDS (I.P.T.)
4130, 4140, 4340	180 - 200	40 - 43	150	0.002 - 0.004	50	0.002 - 0.004
4340, 4330V (MOD)	200 - 220	43 - 46	125	0.002 - 0.004	40	0.002 - 0.004
4330V (MOD) D6AC	220 - 240	46 - 48 1/2	100	0.001 - 0.003	35	0.001 - 0.003
D6AC	240 - 260	48 1/2 - 50 1/2	90	0.001 - 0.002	30	0.001 - 0.003
AF 1410	235 MIN.	47 - 50	90	0.001 - 0.002	30	0.001 - 0.003
300M	280 - 300	53 - 55	75	0.001 - 0.002	NOT ALLOWED	
HP9-4-30	220 - 240	44 - 49	100	0.001 - 0.003	35	0.001 - 0.003
NOTE: RECOMMENDED CUTTING FLUIDS: A. HSS - HEAVY DUTY EMULSIFIABLE OIL. B. CARBIDE - HEAVY DUTY EMULSIFIABLE OILS.						

TABLE 6. GRINDING PARAMETERS FOR HIGH STRENGTH MARTENSITIC STEELS AND MARTENSITIC STAINLESS STEELS

GRINDING METHODS	MAXIMUM WHEEL HARDNESS GRADES	RECOMMENDED A1 ₂ O ₃ GRIT SIZES	MAXIMUM WHEEL SPEEDS (S.F.M.)	ALLOWABLE WORK SPEED RANGES (S.F.M.)	MAXIMUM CROSSFEED OR TRAVERSE	MAXIMUM PERMITTED DOWNFEEDS AND INFEEDES		MINIMUM STOCK REQUIRED FOR FINISHING (INCH)
						ROUGHING (INCH/PASS)	FINISHING (INCH/PASS)	
SURFACE GRINDING (CONVENTIONAL)	K	46 - 80	6600	50 - 100	WHEEL WIDTH 10 (I.P.P.)	0.001	0.0005	0.003 (PER SURFACE)
SURFACE GRINDING "LOW STRESS"	K	46 - 60	3000	50 - 100	0.050 (I.P.P.)	0.001	0.0005	0.003 (PER SURFACE)
CYLINDRICAL GRINDING	K	46 - 80	4000	70 - 1000	WHEEL WIDTH 8 (I.P.W.R.)	0.002 (ON DIA.)	0.0005 (ON DIA.)	0.003 (ON DIA.)
INTERNAL GRINDING	K	46 - 80	4000	75 - 200	WHEEL WIDTH 6 (I.P.W.R.)	0.0005 (ON DIA.)	0.0002 (ON DIA.)	0.001 (ON DIA.)
CENTERLESS GRINDING	K	46 - 80	4000	50 - 70 R.P.M. (REGULATING WHEEL)	50 - 150 I.P.M. (THROUGH FEED OF WORK)	0.003 (ON DIA.)	0.001 (ON DIA.)	0.003 (ON DIA.)

NOTES:

1. RECOMMENDED GRINDING FLUIDS:

- HEAVY DUTY EMULSIFIABLE OILS FOR CONVENTIONAL SURFACE GRINDING, MAY BE USED FOR ALL GRINDING PROCEDURES EXCEPT LOW STRESS SURFACE GRINDING.
- SULFO - CHLORINATED GRINDING OIL OR EQUIVALENT FOR ALL GRINDING PROCEDURES EXCEPT CONVENTIONAL SURFACE GRINDING.
- HEAVY DUTY OILS FOR LOW STRESS SURFACE GRINDING.

- IF PARTS FAIL TO PASS TEMPER ETCH INSPECTION, MAXIMUM WHEEL SPEEDS SHOULD BE REDUCED TO 3,000 S.F.M. AND SULFO-CHLORINATED GRINDING OIL OR EQUIVALENT SHOULD BE USED.

Figure 3. Machining and Grinding Parameters (Sheet 3)

TABLE 7. GRINDING PARAMETERS FOR CHROMIUM PLATED HIGH STRENGTH MARTENSITIC STEELS AND MARTENSITIC STAINLESS STEELS

GRINDING METHODS	MAXIMUM WHEEL HARDNESS GRADES	RECOMMENDED $A_{12}O_3$ GRIT SIZES	MAXIMUM WHEEL SPEEDS (S.F.M.)	ALLOWABLE WORK SPEED RANGES (S.F.M.)	MAXIMUM CROSSFEED OR TRAVERSE	MAXIMUM PERMITTED DOWNFEEDS AND INFEEDES		MINIMUM STOCK REQUIRED FOR FINISHING (INCH)
						ROUGHING (INCH/PASS)	FINISHING (INCH/PASS)	
SURFACE GRINDING	K	46 - 80	4000	30 - 60	WHEEL WIDTH 10 (I.P.P.)	0.0005	0.0002	0.001 (PER SURFACE)CY-LINDRICAL
CYLINDRICAL GRINDING	K	46 - 120	4000	70 - 100	WHEEL WIDTH 8 (I.P.W.R.)	0.001 (ON DIA.)	0.0004 (ON DIA.)	0.002 (ON DIA.)
INTERNAL GRINDING	K	46 - 120	4000	50 - 150	WHEEL WIDTH 6 (I.P.W.R.)	0.0005 (ON DIA.)	0.0002 (ON DIA.)	0.001 (ON DIA.)
CENTERLESS GRINDING	K	46 - 80	4000	50 - 70 R.P.M. (REGULATING WHEEL)	50 - 150 I.P.M. (THROUGH FEED OF WORK)	0.001 (ON DIA.)	0.0004 (ON DIA.)	0.002 (ON DIA.)
NOTES: RECOMMENDED GRINDING FLUIDS: A. SULFO - CHLORINATED GRINDING OIL OR EQUIVALENT FOR ALL GRINDING METHODS. C. HEAVY DUTY EMULSIFIABLE OILS MAY BE USED FOR ALL GRINDING METHODS.								

LEGEND

PSI - POUNDS PER SQUARE INCH.
 SFM - SURFACE FEET PER MINUTE (SPEED).
 IPT - INCHES PER TOOTH (FEED).
 HSS - HIGH SPEED STEEL.
 R_C - ROCKWELL C SCALE HARDNESS.
 IPR - INCHES PER REVOLUTION (FEED).
 FPM - FEET PER MINUTE (TABLE SPEED).
 IPP - INCHES PER PASS (GRINDING FEEDS).
 IPWR - INCHES PER WORK REVOLUTION (TRAVERSE SPEED).
 SUS - SAYBOLT UNIVERSAL SECONDS.

ORGANIZATIONAL, MAINTENANCE

STRUCTURE REPAIR

SHOP PRACTICES

FASTENER HOLE CLASSIFICATION DATA

Reference Material

None

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Record of Applicable Technical Directives

None

1. FASTENER HOLE CLASSIFICATION DATA.

2. This work package is a guide for close tolerance hole fabrication. This work package shall be referenced from specific structure repair series manuals A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750 or from a close tolerance hole fabrication work package.

3. **FASTENER FIT.** Fastener fit should be selected to satisfy application described in specific procedure. Selected fit is made by calling out hole diameter and tolerance as specified for that fit listed in figure 1, tables 1 thru 8.

a. Tables 1 thru 6 are for close tolerance unplated bolts and pins (0.0005 shank tolerance).

b. Tables 7 and 8 are for non-structural screws.

TABLE 1. INTERFERENCE FIT

NOMINAL DIA	FASTENER DIA	HOLE DIA	CLEARANCE
1/8	0.1245 0.1240	—	—
5/32	0.1635 0.1630	0.1600 $\begin{smallmatrix} +0.0025 \\ - 0.0000 \end{smallmatrix}$	$\begin{smallmatrix} -0.0005 \\ -0.0035 \end{smallmatrix}$
3/16	0.1895 0.1890	0.1850 $\begin{smallmatrix} +0.0030 \\ - 0.0000 \end{smallmatrix}$	$\begin{smallmatrix} -0.0010 \\ -0.0045 \end{smallmatrix}$
1/4	0.2495 0.2490	0.2450 $\begin{smallmatrix} +0.0030 \\ - 0.0000 \end{smallmatrix}$	$\begin{smallmatrix} -0.0010 \\ -0.0045 \end{smallmatrix}$
5/16	0.3120 0.3115	0.3075 $\begin{smallmatrix} +0.0030 \\ - 0.0000 \end{smallmatrix}$	$\begin{smallmatrix} -0.0010 \\ -0.0045 \end{smallmatrix}$
3/8	0.3745 0.3740	0.3700 $\begin{smallmatrix} +0.0030 \\ - 0.0000 \end{smallmatrix}$	$\begin{smallmatrix} -0.0010 \\ -0.0045 \end{smallmatrix}$
7/16	0.4370 0.4365	0.4325 $\begin{smallmatrix} +0.0030 \\ - 0.0000 \end{smallmatrix}$	$\begin{smallmatrix} -0.0010 \\ -0.0045 \end{smallmatrix}$
1/2	0.4995 0.4990		
<p style="text-align: center;">LEGEND</p> <ol style="list-style-type: none"> HI-LOK AND LOCKBOLT FASTENERS ARE USED IN ALUMINUM ALLOYS THAT ARE STRESS CORROSION RESISTANT. HI-LOK AND LOCKBOLT FASTENERS ARE USED IN TITANIUM AND ALUMINUM STRUCTURE WHERE TITANIUM THICKNESS IS 0.100 OR LESS. JOINT THICKNESSES SHOULD NOT EXCEED TWO TIMES NOMINAL FASTENER DIAMETER. FASTENERS ARE SEATED USING PLASTIC Mallet OR RIVET GUN, IF VIBRATION SEATING IS ALLOWED, BUT BACKUP IS REQUIRED DURING SEATING. TITANIUM JOINTS LARGER THAN 0.100 INCH THICK REQUIRE FASTENER SEATING BY SQUEEZING. MAKE SURE ENOUGH CLEARANCE IS ALLOWED FOR TOOLING WHEN DRIVING HI-LOK OR LOCKBOLT FASTENERS. FASTENERS USED: HI-LOKS ST3M757, ST3M758, ST3M759, ST3M760, 3M904 LOCKBOLTS PULL TYPE - ST3M828, ST3M829, ST3M832, ST3M852 STUMP TYPE - ST3M861, ST3M873 			

Figure 1. Hole Sizes for Pin and Collar Fasteners and Bolts (Sheet 1)

TABLE 2. CLASS 1 FIT

NOMINAL DIA	FASTENER DIA	HOLE DIA	CLEARANCE
1/8	0.1245 0.1240	0.1245 +0.0015 -0.0007	- 0.0007 +0.0020
5/32	0.1635 0.1630	0.1635 +0.0015 - 0.0007	- 0.0007 +0.0020
3/16	0.1895 0.1890	0.1895 +0.0015 - 0.0007	- 0.0007 +0.0020
1/4	0.2495 0.2490	0.2495 +0.0015 - 0.0007	- 0.0007 +0.0020
5/16	0.3120 0.3115	0.3120 +0.0015 - 0.0007	- 0.0007 +0.0020
3/8	0.3745 0.3740	0.3745 +0.0015 - 0.0007	- 0.0007 +0.0020
7/16	-	-	-
1/2	-	-	-
LEGEND			
1. LOCKBOLTS AND HI-LOKS ONLY.			

TABLE 3. CLASS 2 FIT

NOMINAL DIA	FASTENER DIA	HOLE DIA	CLEARANCE
1/8	0.1245 0.1240	0.1245 +0.0025 -0.0000	0.0000 0.0030
5/32	0.1635 0.1630	0.1635 +0.0025 - 0.0000	0.0000 0.0030
3/16	0.1895 0.1890	0.1895 +0.0025 - 0.0000	0.0000 0.0030
1/4	0.2495 0.2490	0.2495 +0.0025 - 0.0000	0.0000 0.0030
5/16	0.3120 0.3115	0.3120 +0.0020 - 0.0000	0.0000 0.0025
3/8	0.3745 0.3740	0.3745 +0.0020 - 0.0000	0.0000 0.0025
7/16	0.4370 0.4365	0.4370 +0.0020 - 0.0000	0.0000 0.0025
1/2	0.4995 0.4990	0.4995 +0.0020 - 0.0000	0.0000 0.0025
9/16	0.5615 0.5610	0.5620 +0.0020 - 0.0000	0.0005 0.0030
5/8	0.6240 0.6235	0.6245 +0.0020 - 0.0000	0.0005 0.0030
3/4	0.7490 0.7485	0.7495 +0.0020 - 0.0000	0.0005 0.0030
7/8	0.8740 0.8735	0.8745 +0.0020 - 0.0000	0.0005 0.0030
1.0	0.9990 0.9985	0.9995 +0.0020 - 0.0000	0.0005 0.0030

Figure 1. Hole Sizes for Pin and Collar Fasteners and Bolts (Sheet 2)

TABLE 4. CLASS 2G FIT

NOMINAL DIA	FASTENER DIA	HOLE DIA	CLEARANCE
1/8	0.1245 0.1240	–	–
5/32	0.1635 0.1630	0.1635 +0.0030 – 0.0000	0.0005 0.0040
3/16	0.1895 0.1890	0.1900 +0.0030 – 0.0000	0.0005 0.0040
1/4	0.2495 0.2490	0.2500 +0.0030 – 0.0000	0.0005 0.0040
5/16	0.3120 0.3115	0.3125 +0.0030 – 0.0000	0.0005 0.0040
3/8	0.3745 0.3740	0.3750 +0.0030 – 0.0000	0.0005 0.0040
7/16	0.4370 0.4365	0.4370 +0.0030 – 0.0000	0.0005 0.0040
1/2	0.4995 0.4990	0.5000 +0.0030 – 0.0000	0.0005 0.0040
LEGEND			
1. GRAPHITE EPOXY STRUCTURE ONLY.			

TABLE 5. CLASS 3 FIT

NOMINAL DIA	FASTENER DIA	HOLE DIA	CLEARANCE
1/8	0.1245 0.1240	0.127 +0.0006 – 0.0000	0.0025 0.0090
5/32	0.1635 0.1630	0.166 +0.006 – 0.0000	0.0025 0.0090
3/16	0.1895 0.1890	0.191 +0.006 – 0.0000	0.0015 0.0080
1/4	0.2495 0.2490	0.250 +0.006 – 0.000	0.0005 0.0070
5/16	0.3120 0.3115	0.312 +0.007 – 0.0000	0.0000 0.0075
3/8	0.3745 0.3740	0.375 +0.007 – 0.0000	0.0005 0.0080
7/16	0.4370 0.4365	0.4375 +0.007 – 0.0000	0.0005 0.0080
1/2	0.4995 0.4990	0.500 +0.007 – 0.0000	0.0005 0.0080
9/16	0.5615 0.5610	0.562 +0.009 – 0.0000	0.0005 0.0100
5/8	0.6240 0.6235	0.625 +0.008 – 0.001	0.0000 0.0095
3/4	0.7490 0.7485	0.750 +0.008 – 0.001	0.0000 0.0095
7/8	0.8740 0.8735	0.875 +0.010 – 0.001	0.0000 0.0115
1.0	0.9990 0.9985	1.000 +0.010 – 0.001	0.0000 0.0115

Figure 1. Hole Sizes for Pin and Collar Fasteners and Bolts (Sheet 3)

TABLE 6. CLASS D FIT

NOMINAL DIA	FASTENER DIA	HOLE DIA	CLEARANCE
1/8	0.1245 0.1240	0.128 $\begin{smallmatrix} +0.006 \\ - 0.000 \end{smallmatrix}$	0.0035 0.0100
5/32	0.1635 0.1630	0.169 $\begin{smallmatrix} +0.006 \\ - 0.000 \end{smallmatrix}$	0.0055 0.0120
3/16	0.1895 0.1890	0.195 $\begin{smallmatrix} +0.007 \\ - 0.000 \end{smallmatrix}$	0.0065 0.0130
1/4	0.2495 0.2490	0.255 $\begin{smallmatrix} +0.007 \\ - 0.000 \end{smallmatrix}$	0.0075 0.0140
5/16	0.3120 0.3115	0.322 $\begin{smallmatrix} +0.007 \\ - 0.000 \end{smallmatrix}$	0.0040 0.0115
3/8	0.3745 0.3740	0.385 $\begin{smallmatrix} +0.008 \\ - 0.000 \end{smallmatrix}$	0.0115 0.0190
7/16	0.4370 0.4365	0.452 $\begin{smallmatrix} +0.008 \\ - 0.000 \end{smallmatrix}$	0.0150 0.0235
1/2	0.4995 0.4990	0.515 $\begin{smallmatrix} +0.008 \\ - 0.001 \end{smallmatrix}$	0.0145 0.0240
9/16	0.5615 0.5610	0.578 $\begin{smallmatrix} +0.008 \\ - 0.001 \end{smallmatrix}$	0.0155 0.0250
5/8	0.6240 0.6235	0.640 $\begin{smallmatrix} +0.008 \\ - 0.001 \end{smallmatrix}$	0.0150 0.0245
3/4	0.7490 0.7485	0.765 $\begin{smallmatrix} +0.010 \\ - 0.001 \end{smallmatrix}$	0.0150 0.0265
7/8	0.8740 0.8735	0.890 $\begin{smallmatrix} +0.010 \\ - 0.001 \end{smallmatrix}$	0.0150 0.0265
1.0	0.9990 0.9985	1.015 $\begin{smallmatrix} +0.012 \\ - 0.001 \end{smallmatrix}$	0.0150 0.0285

Figure 1. Hole Sizes for Pin and Collar Fasteners and Bolts (Sheet 4)

TABLE 7. CLASS 3 FIT, NON-STRUCTURAL SCREWS

NOMINAL DIA	FASTENER DIA	HOLE DIA	CLEARANCE
NO. 4	0.1115 0.1095	0.113 $\begin{smallmatrix} +0.005 \\ - 0.000 \end{smallmatrix}$	0.0015 0.0075
NO. 6	0.1375 0.1355	0.1405 $\begin{smallmatrix} +0.005 \\ - 0.000 \end{smallmatrix}$	0.0030 0.0100
NO. 8	0.1615 0.1610	0.166 $\begin{smallmatrix} +0.006 \\ - 0.000 \end{smallmatrix}$	0.0025 0.0110
3/16	0.1895 0.1870	0.191 $\begin{smallmatrix} +0.006 \\ - 0.000 \end{smallmatrix}$	0.0015 0.0100
1/4	0.2495 0.2470	0.250 $\begin{smallmatrix} +0.006 \\ - 0.000 \end{smallmatrix}$	0.0005 0.0090
5/16	0.3120 0.3095	0.312 $\begin{smallmatrix} +0.007 \\ - 0.000 \end{smallmatrix}$	0.0000 0.0095
3/8	0.3745 0.3720	0.375 $\begin{smallmatrix} +0.007 \\ - 0.000 \end{smallmatrix}$	0.0005 0.0100

TABLE 8. CLASS D FIT, NON-STRUCTURAL SCREWS

NOMINAL DIA	FASTENER DIA	HOLE DIA	CLEARANCE
NO. 4	0.1115 0.1095	0.116 $\begin{smallmatrix} +0.005 \\ - 0.000 \end{smallmatrix}$	0.0045 0.0115
NO. 6	0.1375 0.1355	0.144 $\begin{smallmatrix} +0.006 \\ - 0.000 \end{smallmatrix}$	0.0065 0.0145
NO. 8	0.1615 0.1610	0.169 $\begin{smallmatrix} +0.006 \\ - 0.000 \end{smallmatrix}$	0.0055 0.0140
3/16	0.1895 0.1870	0.195 $\begin{smallmatrix} +0.007 \\ - 0.000 \end{smallmatrix}$	0.0055 0.0150
1/4	0.2495 0.2470	0.255 $\begin{smallmatrix} +0.007 \\ - 0.000 \end{smallmatrix}$	0.0055 0.0150
5/16	0.3120 0.3095	0.327 $\begin{smallmatrix} +0.007 \\ - 0.000 \end{smallmatrix}$	0.0100 0.0195
3/8	0.3745 0.3720	0.385 $\begin{smallmatrix} +0.008 \\ - 0.000 \end{smallmatrix}$	0.0105 0.0210

Figure 1. Hole Sizes for Pin and Collar Fasteners and Bolts (Sheet 5)

DEPOT MAINTENANCE

STRUCTURE REPAIR

SHOP PRACTICES

ACCESSORY KITS AND SPRAY MIST COOLANT TANK

Reference Material

Structure Repair, General Information	A1-F18AC-SRM-200
Fastener Hole Classification Data	WP004 15
Drilling Machines.....	WP004 17

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Record of Applicable Technical Directives

None

Support Equipment Required

Part Number or Type Designation	Nomenclature
RE374000002-1	Hole Locating Plate Set Accessory Kit
RE574000002-1	Drilling Machines Accessory Kit

Support Equipment Required
(Continued)

Part Number or Type Designation	Nomenclature
RE874000002-1	Spray Mist Coolant Tank

Support Equipment Required (Continued)

Part Number or Type Designation	Nomenclature
74D110325-1001	Aircraft Structure Repair Tool Kit

Materials Required

Specification or Part Number	Nomenclature
CERROBEND	Solder Wire, 157° Melting Point
MIL-C-87962, TYPE 1	Cleaning Cloth
ISOPAR M	Cutting Fluid, Liquid Coolant

1. ACCESSORY KITS AND SPRAY MIST COOLANT TANK.

2. The accessory kits and spray mist coolant tank assist depot personnel when installing a high strength fastener system. Close tolerance and interference fit fastener holes improve fatigue life and help installed fasteners meet specified performance standards.

3. DRILLING MACHINES ACCESSORY KIT, RE574000002-1. See figure 1.

4. The drilling machines accessory kit (accessory kit) provides interface for drilling machines to bushing liners of hole locating plate set accessory kit. The accessory kit is used to guide nominal and first and second oversize twist drills, reamers, and countersinks. The accessory kit also controls countersink depth, interfaces drilling machines with spray mist coolant tank, and provides the path for coolant to reach cutting surface.

5. GENERAL INFORMATION.

a. Nose Adapters, detail A.

(1) Nose adapters are cylindrical tubes made of steel or aluminum.

(2) Nose adapters are threaded to mate with drilling machines on one end and lock on coolant bushings on other end.

(3) A quick disconnect is provided with each nose adapter to interface with spray mist coolant tank.

(4) Nose adapters are provided for all drilling machines used with this accessory kit.

b. Coolant Bushings, details C and D.

(1) Nominal and first and second oversize diameter coolant bushings are provided for all drilling machines.

(2) Coolant bushings provide a path for coolant to reach the cutting surface.

(3) Threaded lock on coolant bushings are required for use with threaded nose adapters.

(4) Threaded lock on coolant bushings also mate with lock on liners provided with the hole locating plate set accessory kit.

c. Microstop Cages, detail B. Four microstop cages are provided for accurate adjustment of countersink depth. The microstop cage has an internal stop which prevents adjustments beyond maximum counterbore depth. Adjust, initially, by tightening skirt all the way in against stop shoulder, then backing off one or two notches.

6. EQUIPMENT SETUP. See detail E.

a. Select correct nose adapter (1).

b. Install nose adapter (1) on drilling machine.

c. Select correct coolant bushing (3) or (4).

d. Install coolant bushing (3) or (4) on nose adapter (1).

e. Select correct microstop cage (2) or cutters and install in drilling machine.

f. Secure drilling machine nose adapter (1) to bushing liner on hole locating plate set.

g. Connect spray mist coolant tank supply hose to quick disconnect on nose adapter (1) or aline-a-drill coolant bushing (3).

h. Fabricate holes as specified in specific structure repair series manuals A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750.

7. HOLE LOCATING PLATE SET ACCESSORY KIT, RE374000002-1. See figure 2.

8. The hole locating plate set accessory kit (accessory kit) is used with different hole locating plate sets to accurately locate centers of nominal and first and second oversize fastener holes. The accessory kit allows for slight differences in hole location from aircraft to aircraft. The accessory kit interfaces with nose adapters and coolant bushings of drilling machines accessory kit.

9. GENERAL INFORMATION.

a. Step Pins, details C and D.

(1) Smaller diameter goes into hole of component skin or substructure.

(2) Larger diameter is inside diameter of required bushing liner.

(3) Pilot hole size step pins are included for use when replacing both skin and substructure, detail C.

(4) Step pins are inserted into holes of skin or substructure and assist to accurately locate bushing liners, detail E.

(5) Step pins are made in nominal and first and second oversize hole sizes.

b. Bushing liners, details A and B.

(1) Bushing liners are potted in hole locating plate using cerrobend.

(2) Straight bushing liners are cylindrical and provide a base for 500 and 2000 RPM drilling machines, detail B and (WP004 17).

(3) Lock on bushing liners are cylindrical with a plate and lock on ears. Lock on ears allow mating bushings on power fed drilling machines to be secured firmly in place by sliding nose adapter plate into lock on bushing liner ears, detail A.

(4) Quantity of each type and size of bushing liner is based on maximum number required to replace any one skin or substructure member.

10. EQUIPMENT SETUP. After correct hole locating plate has been positioned:

a. Install depot made cerrobend sealing washers in chip slots of hole locating plate.

b. Select correct step pin(s) (3) or (4).

c. Install step pin(s) (3) or (4) into mating hole(s) in substructure.

d. Install applicable bushing liner(s) (1) or (2) on step pin(s) (3) or (4).

e. Pot bushing liner(s).

f. Remove step pin from hole(s) or bushing liner(s).

g. Fabricate hole(s) as specified in specific structure repair series manuals A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750.

11. POTTING BUSHING LINERS. See detail E. Pot bushing liner(s) (1) and (2) into position in hole locating plate using melted cerrobend. If same step pin(s) (3) or (4) is required in several holes, it may be moved from hole to hole after cerrobend solidifies.

12. REMOVING AND CLEANING BUSHING LINERS.

 See figure 2.

a. Heat potted bushings in hole locating plate with hot air gun or by putting plate into boiling water until cerrobend melts, approximately 157°.

b. Remove bushing liner(s) (1) and (2) from hole locating plate.

c. Wipe bushing liner(s) (1) and (2) clean with clean dry cloth and stow.

d. Remove cerrobend sealing washers from hole locating plate.

e. Wipe hole locating plate with clean dry cloth and stow.

13. SPRAY MIST COOLANT TANK RE874000002-1.

 See figure 3.

14. The spray mist coolant tank (coolant tank) interfaces with all coolant bushing and drilling machine nose adapters supplied with depot maintenance fixtures and plate sets. It provides a heavy mist of coolant through coolant bushings to

cutting surface when hole locating plate sets are used. The coolant tank also interfaces with boring, reaming, and spot facing equipment.

15. COOLANT.



Immunol #1809 coolant should not be used in this coolant tank system due to its clogging effect.

a. ISOPAR M coolant without butyl cellulose additive should be used for cooling holes machined in acrylic transparencies of windshield and canopy.

b. A mix ratio of one part ISOPAR M to 30 parts water should be used for cooling holes machined in acrylic transparencies of windshield and canopy.

c. Water may be used for cooling holes machined in graphite epoxy laminate, titanium, and aluminum.

16. EQUIPMENT SETUP.

a. Remove filler cap (4) from coolant tank (5).

b. Fill coolant tank (5) with coolant.

c. Reinstall filler cap (4).

d. Connect shop air supply to air inlet, male quick disconnect (2), on coolant tank (5), 90 psi required.

e. Connect one coolant supply hose to female quick disconnect (7) on coolant tank (5).

f. Connect other end of coolant supply hose to male quick disconnect (2) on nose adapter or inline-a-drill coolant bushing on drilling machine.



Make sure heavy mist of coolant is flowing through coolant bushing at all times when drilling. Absence of enough coolant will result in cutting tool or hole degradation.

g. Adjust applicable flow valve (1) to get heavy mist of coolant. Heavy mist of coolant will give a

wet look on the hand when held perpendicular to and about 2 inches from coolant bushing.

h. Coolant tank and system should be rinsed thoroughly with clean water after using Isopar M coolant.

17. AIRCRAFT STRUCTURE REPAIR TOOL KIT, 74D110325-1001. See figure 4.

18. The aircraft structure repair tool kit (tool kit) is made up of various twist drills, flat flute drill bits, reamers, countersinks, traveler bushings, and traveler bushing handles. These tools are required to repair or replace structural components and are similar to production tools. Nominal and first and second oversized tools have been included in this tool kit. Tool selection is based on information specified in specific structure repair series manuals A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750 and (WP004 15).

19. TOOL KIT GENERAL INFORMATION.

a. Twist drills and drill bits (1) are standard tools modified for specific use.

b. Flat flute drill bit (3) has a dagger tip which slices through back of graphite epoxy material instead of pushing through like conventional twist drills, detail A.

c. Reamers (2).

d. One piece countersink (4) is used with microstop cage, detail B.

e. Carbide countersink body (5) is used with microstop cage. The carbide countersink insert (6) is secured to carbide countersink body (5) using carbide insert cam pin (7), detail C.

f. Traveler bushing (10) is used with pistol grip drill motors to drill holes when using a drill plate. The traveler bushing is used to guide the cutter, detail D.

g. Traveler bushing handle (9) holds traveler bushings when using pistol grip drill motors for free hand drilling, detail D.

h. Setscrew (8) holds traveler bushing (10) in traveler bushing handle (9), detail D.

20. **TOOL SELECTION.** The tools are standard, but modified for specific structure repair uses. Tools in

kit are stamped with circle letter numbers and tool diameter. In specific repair numbers tools are identified by TFIM numbers. Tables 1 through 8 identify these tools for correct selection, replacement, and stowing.

a. Select correct maintenance fixture, hole locating plate, or freehand.

b. Install maintenance fixture or hole locating plate as required.

c. Select correct cutter (WP004 15).

d. Install cutter in drilling machine (WP004 17).

e. If freehand drilling is used through a maintenance fixture or hole locating plate, applicable traveler bushing (10) is used to guide the cutter.

(1) Select correct traveler bushing (10).

(2) Use traveler bushing handle (9).

(3) Install traveler bushing (10) in traveler bushing handle (9) using traveler bushing setscrew (8).

f. Fabricate holes as specified in specific structure repair series manuals A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750.

Table 1. Traveler Bushings

Part Number
TD371D-388
TD371D-389
TD371D-67
TD371D-68
TD371D-73
TD371D-76
TD371D-79

Table 1. Traveler Bushings

Part Number
TD371P-2
TD755C-15
TD755C-20
TD755C-24
TD755C-27
TD755C-3
TD755C-30
TD755C-32
TD755C-36
TD755C-38
TD755C-39
TD755C-42
TD755C-51
TD755C-52
TD755C-53
TD755C-56
TD755C-57
TD755C-58
TD755C-60
TD755C-61
TD755C-8
NOTE
Use TD755C-84 traveler bushing handle.

Table 2. Countersink Bodies

Part Number	Circle Letter	Diameter	Pilot Diameter
TFIM25.0120126	L	0.625	0.126
TFIM25.0120158	L	0.625	0.158
TFIM25.0120161	L	0.625	0.161
TFIM25.0120177	L	0.625	0.177
TFIM25.0120187	L	0.625	0.187
TFIM25.0120192	L	0.625	0.192
TFIM25.0120196	L	0.625	0.196
TFIM25.0120200	L	0.625	0.200
TFIM25.0120205	L	0.625	0.205
TFIM25.0120212	L	0.625	0.212
TFIM25.0120215	L	0.625	0.215
TFIM25.0120221	L	0.625	0.221
TFIM25.0120242	L	0.625	0.242
TFIM25.0120247	L	0.625	0.247
TFIM25.0120252	L	0.625	0.252
TFIM25.0120257	L	0.625	0.257
TFIM25.0120262	L	0.625	0.262
TFIM25.0120268	L	0.625	0.268
TFIM25.0120273	L	0.625	0.273
TFIM25.0120278	L	0.625	0.278
TFIM25.0120283	L	0.625	0.283
TFIM25.0120304	L	0.750	0.304
TFIM25.0120309	L	0.750	0.309
TFIM25.0120319	L	0.750	0.319
TFIM25.0120324	L	0.750	0.324

Table 2. Countersink Bodies (Continued)

Part Number	Circle Letter	Diameter	Pilot Diameter
TFIM25.0120335	L	0.750	0.335
TFIM25.0120340	L	0.750	0.340
TFIM25.0120350	L	0.750	0.350
TFIM25.0120367	L	0.875	0.367
TFIM25.0120372	L	0.875	0.372
TFIM25.0120387	L	0.875	0.387
TFIM25.0120403	L	0.875	0.403
TFIM25.0120429	L	01.00	0.420
TFIM25.0120434	L	01.00	0.434
TFIM25.0120450	L	01.00	0.450
TFIM25.0120465	L	01.00	0.465

Table 3. Countersink Inserts

Part Number
TFIM25.0121492
TFIM25.0121493

Table 3. Countersink Inserts

Part Number
TFIM25.0121497
NOTE
Use countersink cam pin, P/N TFIM25.0122001

Table 4. Countersinks

Part Number	Circle Letter	Diameter	Pilot Diameter
ACT350-0		0.625	0.0955
TFIM25.0130644	S	0.375	0.111
TFIM25.0130674	S	0.375	0.114
TFIM25.0130724	S	0.375	0.138
TFIM25.0130744	S	0.375	0.142
TFIM25.0130834	S	0.375	0.164
TFIM25.0130844	S	0.375	0.167
TFIM25.0140824	R	0.375	0.159

Table 4. Countersinks (Continued)

Part Number	Circle Letter	Diameter	Pilot Diameter
TFIM25.0140834	R	0.375	0.164
TFIM25.0140884	R	0.375	0.178
TFIM25.0140904	R	0.500	0.183
TFIM25.0141044	R	0.500	0.187
TFIM25.0141144	R	0.500	0.211
TFIM25.0141344	R	0.625	0.244
TFIM25.0141354	R	0.625	0.247
TFIM25.0141574	R	0.375	0.158
TFIM25.0141584	R	0.750	0.305
TFIM25.0141594	R	0.750	0.309
TFIM25.0141604	R	0.375	0.162
TFIM25.0141634	R	0.750	0.325
TFIM25.0141684	R	0.375	0.167
TFIM25.0141874	R	0.500	0.188
TFIM25.0141894	R	0.500	0.189
TFIM25.0141904	R	0.500	0.193
TFIM25.0141914	R	0.500	0.196
TFIM25.0141934	R	0.875	0.366
TFIM25.0141944	R	0.875	0.372
TFIM25.0142014	R	0.500	0.201
TFIM25.0142114	R	0.500	0.212
TFIM25.0142214	R	0.500	0.222
TFIM25.0142244	R	1.00	0.436
TFIM25.0142254	R	1.00	0.451
TFIM25.0142264	R	1.00	0.467

Table 4. Countersinks (Continued)

Part Number	Circle Letter	Diameter	Pilot Diameter
TFIM25.0142274	R	1.00	0.482
TFIM25.0142404	R	1.125	0.498
TFIM25.0142424	R	0.625	0.243
TFIM25.0142434	R	1.125	0.514
TFIM25.0142464	R	1.125	0.529
TFIM25.0142494	R	1.125	0.544
TFIM25.0142534	R	0.625	0.253
TFIM25.0142574	R	0.625	0.257
TFIM25.0142624	R	0.625	0.262
TFIM25.0142684	R	0.625	0.268
TFIM25.0142734	R	0.625	0.273
TFIM25.0142784	R	0.625	0.275
TFIM25.0142844	R	0.625	0.284
TFIM25.0143094	R	0.750	0.309
TFIM25.0143194	R	0.750	0.319
TFIM25.0143254	R	0.750	0.325
TFIM25.0143364	R	0.750	0.336
TFIM25.0143404	R	0.750	0.340
TFIM25.0143504	R	0.750	0.350
TFIM25.0143674	R	0.875	0.367
TFIM25.0143824	R	0.875	0.382
TFIM25.0143874	R	0.875	0.387
TFIM25.0143984	R	0.875	0.392
TFIM25.0144024	R	0.875	0.402
TFIM25.0144654	R	1.00	0.465

Table 5. Piloted Countersinks

Part Number	Diameter	Pilot Diameter
TFIM25.0036006	0.0960	0.0780
TFIM25.0036030	0.1580	0.0780
TFIM25.0036043	0.1930	0.0780
NOTE Use with TF1M25.0110054 countersink body.		

Table 6. Twist Drills and Drill Bits

Part Number	Equiv Size	Circle Letter	Diameter
TFIM25.0201032	40	A	0.0980
TFIM25.0201048	33	A	0.1130
TFIM25.0201050	32	A	0.1160
TFIM25.0201056	30	A	0.1285
TFIM25.0201060	28	A	0.1405
TFIM25.0201064	27	A	0.1440
TFIM25.0201066	26	A	0.1470
TFIM25.0201074	5/32	A	0.1562
TFIM25.0201080	20	A	0.1610
TFIM25.0201082	19	A	0.1660
TFIM25.0201084	18	A	0.1695
TFIM25.0201086	11/64	A	0.1719
TFIM25.0201090	16	A	0.1770
TFIM25.0201098	3/16	A	0.1875
TFIM25.0201102	11	A	0.1910
TFIM25.0201106	9	A	0.1960
TFIM25.0201122	7/32	A	0.2188

Table 6. Twist Drills and Drill Bits (Continued)

Part Number	Equiv Size	Circle Letter	Diameter
TFIM25.0201130	15/64	A	0.2344
TFIM25.0201136	D	A	0.2460
TFIM25.0201138	1/4	A	0.2500
TFIM25.0201140	F	A	0.2570
TFIM25.0201154	9/32	A	0.2812
TFIM25.0201160	19/64	A	0.2969
TFIM25.0201164	5/16	A	0.3125
TFIM25.0204050	40	D	0.0980
TFIM25.0204060	7/64	D	0.1094
TFIM25.0204066	33	D	0.1130
TFIM25.0204068	32	D	0.1160
TFIM25.0204074	30	D	0.1285
TFIM25.0204078	28	D	0.1405
TFIM25.0204082	27	D	0.1440
TFIM25.0204084	26	D	0.1470
TFIM25.0204092	5/32	D	0.1562
TFIM25.0204098	20	D	0.1610
TFIM25.0204100	19	D	0.1660
TFIM25.0204102	18	D	0.1695
TFIM25.0204104	11/64	D	0.1719
TFIM25.0204108	16	D	0.1770
TFIM25.0204116	3/16	D	0.1875
TFIM25.0204120	11	D	0.1910
TFIM25.0204124	9	D	0.1960
TFIM25.0204140	7/32	D	0.2188

Table 6. Twist Drills and Drill Bits (Continued)

Part Number	Equiv Size	Circle Letter	Diameter
TFIM25.0204148	15/64	D	0.2344
TFIM25.0204154	D	D	0.2460
TFIM25.0204156	1/4	D	0.2500
TFIM25.0204158	F	D	0.2570
TFIM25.0204172	9/32	D	0.2812
TFIM25.0204178	19/64	D	0.2969
TFIM25.0204182	5/16	D	0.3125
TFIM25.0204186	P	D	0.3230
TFIM25.0204194	11/32	D	0.3438
TFIM25.0204200	23/64	D	0.3594
TFIM25.0204204	3/8	D	0.3750
TFIM25.0204208	W	D	0.3860
TFIM25.0204216	13/32	D	0.4062
TFIM25.0204220	27/64	D	0.4219
TFIM25.0204222	7/16	D	0.4375
TFIM25.0204224	29/64	D	0.4531
TFIM25.0204228	31/64	D	0.4844
TFIM25.0204230	1/2	D	0.5000
TFIM25.0204394	6.5mm	D	0.2559
TFIM25.0213001	40	U	0.0980
TFIM25.0213004	30	U	0.1285
TFIM25.0213014	26	U	0.1470
TFIM25.0213022	5/32	U	0.1562
TFIM25.0213028	20	U	0.1610
TFIM25.0213030	19	U	0.1660

Table 6. Twist Drills and Drill Bits (Continued)

Part Number	Equiv Size	Circle Letter	Diameter
TFIM25.0213032	18	U	0.1695
TFIM25.0213034	11/64	U	0.1719
TFIM25.0213038	16	U	0.1770
TFIM25.0213046	12	U	0.1890
TFIM25.0213050	11	U	0.1910
TFIM25.0213054	9	U	0.1960
TFIM25.0213070	7/32	U	0.2188
TFIM25.0213078	15/64	U	0.2344
TFIM25.0213084	D	U	0.2460
TFIM25.0213086	1/4	U	0.2500
TFIM25.0213088	F	U	0.2570
TFIM25.0213102	9/32	U	0.2812
TFIM25.0213108	19/64	U	0.2969
TFIM25.0213112	5/16	U	0.3125
TFIM25.0213114	O	U	0.3160
TFIM25.0213116	P	U	0.3230
TFIM25.0213124	11/32	U	0.3438
TFIM25.0213130	23/64	U	0.3594
TFIM25.0213134	3/8	U	0.3750
TFIM25.0213138	W	U	0.3860
TFIM25.0213146	13/32	U	0.4062
TFIM25.0213150	27/64	U	0.4219
TFIM25.0213152	7/16	U	0.4375
TFIM25.0213154	29/64	U	0.4531
TFIM25.0213158	31/64	U	0.4843

Table 6. Twist Drills and Drill Bits (Continued)

Part Number	Equiv Size	Circle Letter	Diameter
TFIM25.0213160	1/2	U	0.5000
TFIM25.0214066	33	V	0.1130
TFIM25.0214068	32	V	0.1160
TFIM25.0214078	28	V	0.1405
TFIM25.0214082	27	V	0.1440
TFIM25.0218032	40	Z	0.0980
TFIM25.0218048	33	Z	0.1130
TFIM25.0218050	32	Z	0.1160
TFIM25.0218056	30	Z	0.1285
TFIM25.0218060	28	Z	0.1405
TFIM25.0218064	27	Z	0.1440
TFIM25.0218066	26	Z	0.1470
TFIM25.0218074	5/32	Z	0.1562
TFIM25.0218080	20	Z	0.1610
TFIM25.0218082	19	Z	0.1660
TFIM25.0218084	18	Z	0.1695
TFIM25.0218086	11/64	Z	0.1719
TFIM25.0218090	16	Z	0.1770
TFIM25.0218098	3/16	Z	0.1875
TFIM25.0218102	11	Z	0.1910
TFIM25.0218106	9	Z	0.1960
TFIM25.0218122	7/32	Z	0.2188
TFIM25.0218130	15/64	Z	0.2344
TFIM25.0218136	D	Z	0.2460
TFIM25.0218138	1/4	Z	0.2500

Table 6. Twist Drills and Drill Bits (Continued)

Part Number	Equiv Size	Circle Letter	Diameter
TFIM25.0218140	P	Z	0.2570
TFIM25.0218154	9/32	Z	0.2812
TFIM25.0218160	19/64	Z	0.2969
TFIM25.0218164	5/16	Z	0.3125
TFIM25.0234116	40	AC	0.0980
TFIM25.0234119	32	AC	0.1160
TFIM25.0234125	30	AC	0.1285
TFIM25.0234134	5/32	AC	0.1562
TFIM25.0234137	20	AC	0.1610
TFIM25.0234139	19	AC	0.1660
TFIM25.0234141	16	AC	0.1770
TFIM25.0234143	3/16	AC	0.1875
TFIM25.0234146	11	AC	0.1910
TFIM25.0234149	9	AC	0.1960
TFIM25.0234152	5	AC	0.2055
TFIM25.0234164	1/4	AC	0.2500
TFIM25.0234166	F	AC	0.2570
TFIM25.0234172	K	AC	0.2810
TFIM25.0234176	19/64	AC	0.2969
TFIM25.0234185	P	AC	0.3230
TFIM25.0235128	30	S	0.1285
TFIM25.0235152	24	S	0.1520
TFIM25.0235161	20	S	0.1610
TFIM25.0235166	19	S	0.1660
TFIM25.0235177	16	S	0.1770

Table 6. Twist Drills and Drill Bits (Continued)

Part Number	Equiv Size	Circle Letter	Diameter
TFIM25.0235185	13	S	0.1850
TFIM25.0235191	11	S	0.1910
TFIM25.0235218	7/32	S	0.2188
TFIM25.0235234	15/64	S	0.2344
TFIM25.0235252	6.4mm	S	0.2520
TFIM25.0235281	9/32	S	0.2812
TFIM25.0235296	19/64	S	0.2969
TFIM25.0235315	8mm	S	0.3150
TFIM25.0235343	11/32	S	0.3438
TFIM25.0235359	23/64	S	0.3594
TFIM25.0235377	V	S	0.3770
TFIM25.0235406	13/32	S	0.4062
TFIM25.0235421	27/64	S	0.4219
TFIM25.0253155	40	L	0.0980
TFIM25.0253199	30	L	0.1285
TFIM25.0253239	20	L	0.1610
TFIM25.0253243	4.19mm	L	0.1650
TFIM25.0253279	11	L	0.1910
TFIM25.0253285	9	L	0.1960
TFIM25.0253289	5.07mm	L	0.1998
TFIM25.0253331	A	L	0.2340
TFIM25.0253352	6.38mm	L	0.2510
TFIM25.0253353	6.4mm	L	0.2520
TFIM25.0253355	6.5mm	L	0.2559
TFIM25.0253401	19/64	L	0.2969

Table 6. Twist Drills and Drill Bits (Continued)

Part Number	Equiv Size	Circle Letter	Diameter
TFIM25.0253416	7.96mm	L	0.3135
TFIM25.0253417	8mm	L	0.3150
TFIM25.0253425	P	L	0.3230
TFIM25.0253461	23/64	L	0.3594
TFIM25.0253505	27/64	L	0.4219
TFIM25.0253509	7/16	L	0.4375
TFIM25.0253705	7.82mm	L	0.3080
TFIM25.0253721	6.24mm	L	0.2455
TFIM25.0253723	4.71mm	L	0.1855
TFIM25.0253725	6.62mm	L	0.2608
TFIM25.0253734	9.55mm	L	0.3760

Table 7. Reamers

Part Number	Circle Letter	Diameter
TFIM25.1111227	C	0.1227
TFIM25.1111852	C	0.1852
TFIM25.1111983	C	0.1983
TFIM25.1112139	C	0.2139
TFIM25.1112352	C	0.2352
TFIM25.1112452	C	0.2452
TFIM25.1112497	C	0.2497
TFIM25.1112512	C	0.2512
TFIM25.1112608	C	0.2608
TFIM25.1112653	C	0.2653
TFIM25.1112669	C	0.2669

Table 7. Reamers (Continued)

Part Number	Circle Letter	Diameter
TFIM25.1112764	C	0.2764
TFIM25.1112809	C	0.2809
TFIM25.1112972	C	0.2972
TFIM25.1113077	C	0.3077
TFIM25.1113122	C	0.3122
TFIM25.1113133	C	0.3133
TFIM25.1113233	C	0.3233
TFIM25.1113255	C	0.3255
TFIM25.1113278	C	0.3278
TFIM25.1113295	C	0.3295
TFIM25.1113378	C	0.3378
TFIM25.1113389	C	0.3389
TFIM25.1113434	C	0.3434
TFIM25.1113534	C	0.3534
TFIM25.1113592	C	0.3592
TFIM25.1113702	C	0.3702
TFIM25.1113747	C	0.3747
TFIM25.1113752	C	0.3752
TFIM25.1113858	C	0.3858
TFIM25.1113903	C	0.3903
TFIM25.1113908	C	0.3908
TFIM25.1113919	C	0.3919
TFIM25.1114014	C	0.4014
TFIM25.1114059	C	0.4059
TFIM25.1114064	C	0.4064

Table 7. Reamers (Continued)

Part Number	Circle Letter	Diameter
TFIM25.1114174	C	0.4174
TFIM25.1114212	C	0.4212
TFIM25.1114372	C	0.4372
TFIM25.1114514	C	0.4514
TFIM25.1114528	C	0.4528
TFIM25.1114533	C	0.4533
TFIM25.1114684	C	0.4684
TFIM25.1114689	C	0.4689
TFIM25.1114844	C	0.4844
TFIM25.1114997	C	0.4997
TFIM25.1115153	C	0.5153
TFIM25.1115158	C	0.5158
TFIM25.1115309	C	0.5309
TFIM25.1115314	C	0.5314
TFIM25.1115454	C	0.5454
TFIM25.1211432	S	0.1432
TFIM25.1211605	S	0.1605
TFIM25.1211615	S	0.1615
TFIM25.1211650	S	0.1650
TFIM25.1211772	S	0.1772
TFIM25.1211808	S	0.1808
TFIM25.1211880	S	0.1880
TFIM25.1211910	S	0.1910
TFIM25.1211960	S	0.1960
TFIM25.1211986	S	0.1986

Table 7. Reamers (Continued)

Part Number	Circle Letter	Diameter
TFIM25.1211998	S	0.1998
TFIM25.1212034	S	0.2034
TFIM25.1212083	S	0.2083
TFIM25.1212120	S	0.2120
TFIM25.1212142	S	0.2142
TFIM25.1212158	S	0.2158
TFIM25.1212190	S	0.2190
TFIM25.1212239	S	0.2239
TFIM25.1212352	S	0.2352
TFIM25.1212455	S	0.2455
TFIM25.1212473	S	0.2473
TFIM25.1212510	S	0.2510
TFIM25.1212608	S	0.2608
TFIM25.1212611	S	0.2611
TFIM25.1212623	S	0.2623
TFIM25.1212659	S	0.2659
TFIM25.1212669	S	0.2669
TFIM25.1212708	S	0.2708
TFIM25.1212767	S	0.2767
TFIM25.1212783	S	0.2783
TFIM25.1212815	S	0.2815
TFIM25.1212864	S	0.2864
TFIM25.1212972	S	0.2972
TFIM25.1213093	S	0.3093
TFIM25.1213135	S	0.3135

Table 7. Reamers (Continued)

Part Number	Circle Letter	Diameter
TFIM25.1213236	S	0.3236
TFIM25.1213255	S	0.3255
TFIM25.1213284	S	0.3284
TFIM25.1213378	S	0.3378
TFIM25.1213392	S	0.3392
TFIM25.1213403	S	0.3403
TFIM25.1213440	S	0.3440
TFIM25.1213534	S	0.3534
TFIM25.1213592	S	0.3592
TFIM25.1213705	S	0.3705
TFIM25.1213760	S	0.3760
TFIM25.1213861	S	0.3861
TFIM25.1213909	S	0.3909
TFIM25.1213919	S	0.3919
TFIM25.1214017	S	0.4017
TFIM25.1214065	S	0.4065
TFIM25.1214212	S	0.4212
TFIM25.1214219	S	0.4219
TFIM25.1214330	S	0.4330
TFIM25.1214373	S	0.4373
TFIM25.1214385	S	0.4385
TFIM25.1214486	S	0.4486
TFIM25.1214534	S	0.4534
TFIM25.1214642	S	0.4642
TFIM25.1214690	S	0.4690

Table 8. Piloted Reamers

Part Number	Circle Letter	Diameter	Pilot Diameter
TFIM25.1131400	F	0.1432	0.1263
TFIM25.1131700	F	0.1772	0.1588
TFIM25.1131900	F	0.1928	0.1750
TFIM25.1132010	F	0.2084	0.1906
TFIM25.1132510	F	0.2352	0.2166
TFIM25.1132810	F	0.2512	0.2330
TFIM25.1133120	F	0.2669	0.2490
TFIM25.1133803	F	0.2972	0.2790
TFIM25.1134115	F	0.3133	0.2950
TFIM25.1134420	F	0.3295	0.3111
TFIM25.1134980	F	0.3592	0.3416
TFIM25.1135405	F	0.3753	0.3570
TFIM25.1135710	F	0.3919	0.3731
TFIM25.1161602	D	0.1602	0.1450
TFIM25.1161637	D	0.1637	0.1450
TFIM25.1161652	D	0.1652	0.1542
TFIM25.1161801	D	0.1801	0.1640
TFIM25.1161807	D	0.1807	0.1630
TFIM25.1161852	D	0.1852	0.1699
TFIM25.1161897	D	0.1897	0.1750
TFIM25.1161911	D	0.1911	0.1750
TFIM25.1161961	D	0.1961	0.1800
TFIM25.1161992	D	0.1992	0.1855
TFIM25.1162028	D	0.2028	0.1875
TFIM25.1162043	D	0.2043	0.1870

Table 8. Piloted Reamers (Continued)

Part Number	Circle Letter	Diameter	Pilot Diameter
TFIM25.1162093	D	0.2093	0.1940
TFIM25.1162152	D	0.2152	0.1970
TFIM25.1162184	D	0.2184	0.2006
TFIM25.1162199	D	0.2199	0.2021
TFIM25.1162249	D	0.2249	0.2071
TFIM25.1162452	D	0.2452	0.2324
TFIM25.1162497	D	0.2497	0.2324
TFIM25.1162502	D	0.2502	0.2324
TFIM25.1162571	D	0.2571	0.2400
TFIM25.1162602	D	0.2702	0.2440
TFIM25.1162608	D	0.2608	0.2430
TFIM25.1162653	D	0.2653	0.2475
TFIM25.1162658	D	0.2658	0.2480
TFIM25.1162721	D	0.2721	0.2550
TFIM25.1162762	D	0.2762	0.2580
TFIM25.1162764	D	0.2764	0.2586
TFIM25.1162809	D	0.2809	0.2631
TFIM25.1162814	D	0.2814	0.2636
TFIM25.1162901	D	0.2901	0.2700
TFIM25.1163077	D	0.3077	0.2949
TFIM25.1163122	D	0.3122	0.2949
TFIM25.1163127	D	0.3127	0.2949
TFIM25.1163233	D	0.3233	0.3055
TFIM25.1163278	D	0.3278	0.3100
TFIM25.1163389	D	0.3389	0.3211

Table 8. Piloted Reamers (Continued)

Part Number	Circle Letter	Diameter	Pilot Diameter
TFIM25.1163434	D	0.3434	0.3256
TFIM25.1163702	D	0.3702	0.3574
TFIM25.1163747	D	0.3747	0.3574
TFIM25.1163752	D	0.3752	0.3574
TFIM25.1163858	D	0.3858	0.3680
TFIM25.1163903	D	0.3903	0.3725
TFIM25.1163908	D	0.3908	0.3730
TFIM25.1164014	D	0.4014	0.3836
TFIM25.1164018	D	0.4018	0.3837
TFIM25.1164059	D	0.4059	0.3881
TFIM25.1164064	D	0.4064	0.3886
TFIM25.1164174	D	0.4174	0.3996
TFIM25.1171602	B	0.1602	0.1450
TFIM25.1171637	B	0.1637	0.1450
TFIM25.1171652	B	0.1652	0.1542
TFIM25.1171807	B	0.1807	0.1630
TFIM25.1172452	B	0.2452	0.2260
TFIM25.1172497	B	0.2497	0.2324
TFIM25.1172602	B	0.2602	0.2440
TFIM25.1172608	B	0.2608	0.2430
TFIM25.1172658	B	0.2658	0.2480
TFIM25.1172728	B	0.2728	0.2550
TFIM25.1172762	B	0.2762	0.2580
TFIM25.1172764	B	0.2764	0.2580
TFIM25.1172809	B	0.2809	0.2631

Table 8. Piloted Reamers (Continued)

Part Number	Circle Letter	Diameter	Pilot Diameter
TFIM25.1172814	B	0.2814	0.2636
TFIM25.1172884	B	0.2884	0.2706
TFIM25.1173122	B	0.3122	0.2949
TFIM25.1173278	B	0.3278	0.3100
TFIM25.1173434	B	0.3434	0.3256
TFIM25.1181852	A	0.1852	—
TFIM25.1181897	A	0.1897	—
TFIM25.1181992	A	0.1992	—
TFIM25.1261643	T	0.1643	0.1595
TFIM25.1261897	T	0.1897	0.1845
TFIM25.1261903	T	0.1903	0.1845
TFIM25.1262028	T	0.2028	0.1976
TFIM25.1262034	T	0.2034	0.1976
TFIM25.1262184	T	0.2184	0.2132
TFIM25.1262190	T	0.2190	0.2132
TFIM25.1262497	T	0.2497	0.2445
TFIM25.1262503	T	0.2503	0.2345
TFIM25.1262504	T	0.2503	0.2445
TFIM25.1262653	T	0.2653	0.2601
TFIM25.1262658	T	0.2659	0.2490
TFIM25.1262659	T	0.2659	0.2505
TFIM25.1262809	T	0.2809	0.2757
TFIM25.1262815	T	0.2815	0.2662
TFIM25.1262816	T	0.2815	0.2757
TFIM25.1263122	T	0.3122	0.3070

Table 8. Piloted Reamers (Continued)

Part Number	Circle Letter	Diameter	Pilot Diameter
TFIM25.1263128	T	0.3128	0.2965
TFIM25.1263129	T	0.3128	0.3070
TFIM25.1263278	T	0.3278	0.3226
TFIM25.1263284	T	0.3284	0.3126
TFIM25.1263285	T	0.3284	0.3226
TFIM25.1263434	T	0.3434	0.3382
TFIM25.1263440	T	0.3440	0.3248
TFIM25.1263441	T	0.3440	0.3382
TFIM25.1263747	T	0.3747	0.3695
TFIM25.1263753	T	0.3753	0.3585
TFIM25.1263754	T	0.3753	0.3695
TFIM25.1263903	T	0.3903	0.3851
TFIM25.1263909	T	0.3909	0.3746
TFIM25.1263910	T	0.3909	0.3851
TFIM25.1264059	T	0.4059	0.4006
TFIM25.1264065	T	0.4065	0.3912
TFIM25.1264066	T	0.4065	0.4007
TFIM25.1264378	T	0.4378	0.4205
TFIM25.1264379	T	0.4378	0.4320
TFIM25.1264534	T	0.4534	0.4366
TFIM25.1264535	T	0.4534	0.4476
TFIM25.1264689	T	0.4690	0.4514
TFIM25.1264690	T	0.4690	0.4632
TFIM25.1302471	Z	0.2470	0.2330
TFIM25.1302481	Z	0.2480	0.2330

Table 8. Piloted Reamers (Continued)

Part Number	Circle Letter	Diameter	Pilot Diameter
TFIM25.1302621	Z	0.2620	0.2460
TFIM25.1302776	Z	0.2775	0.2610
TFIM25.1303091	Z	0.3091	0.2950
TFIM25.1303241	Z	0.3240	0.3060
TFIM25.1303401	Z	0.3400	0.3230

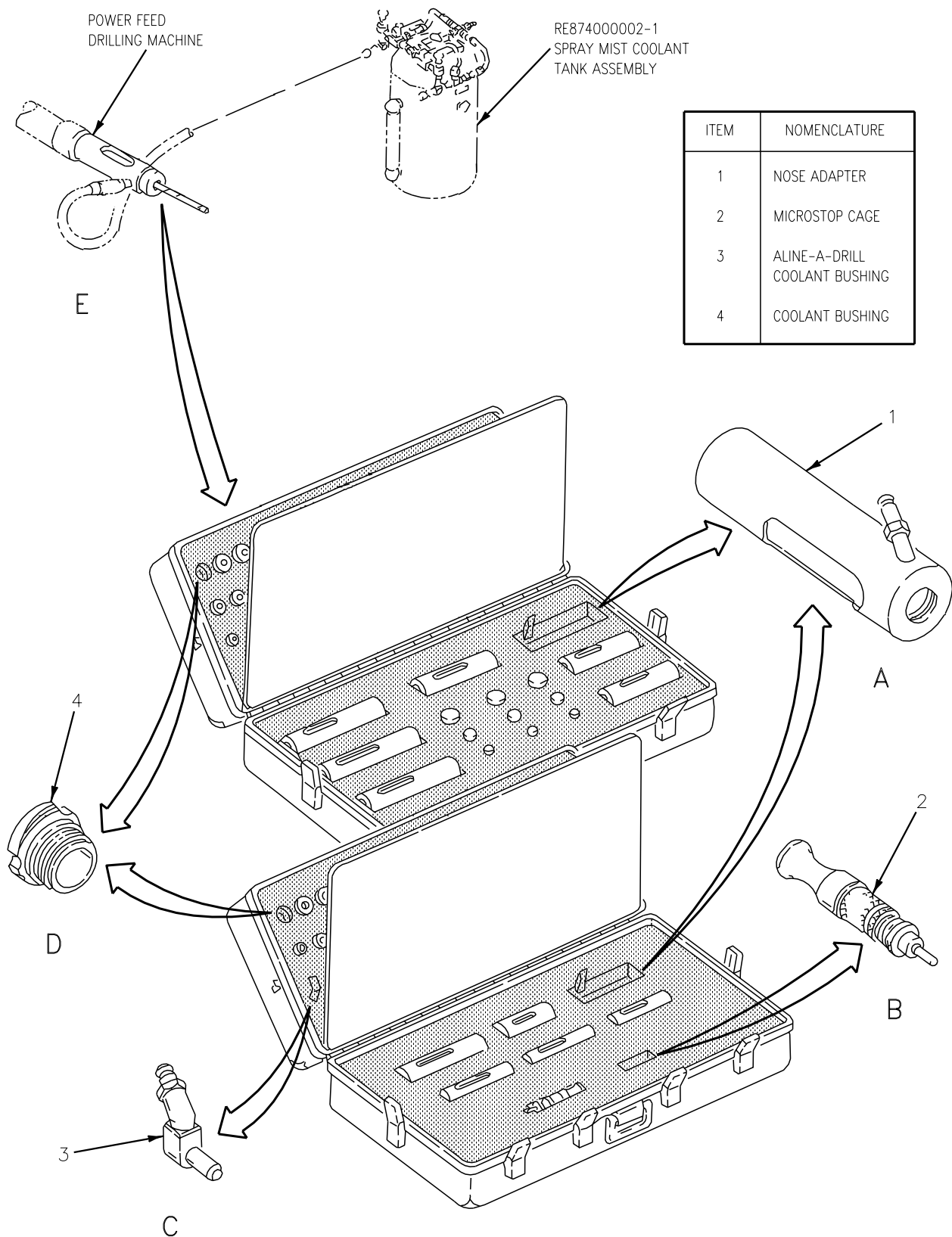


Figure 1. Drilling Machines Accessory Kit

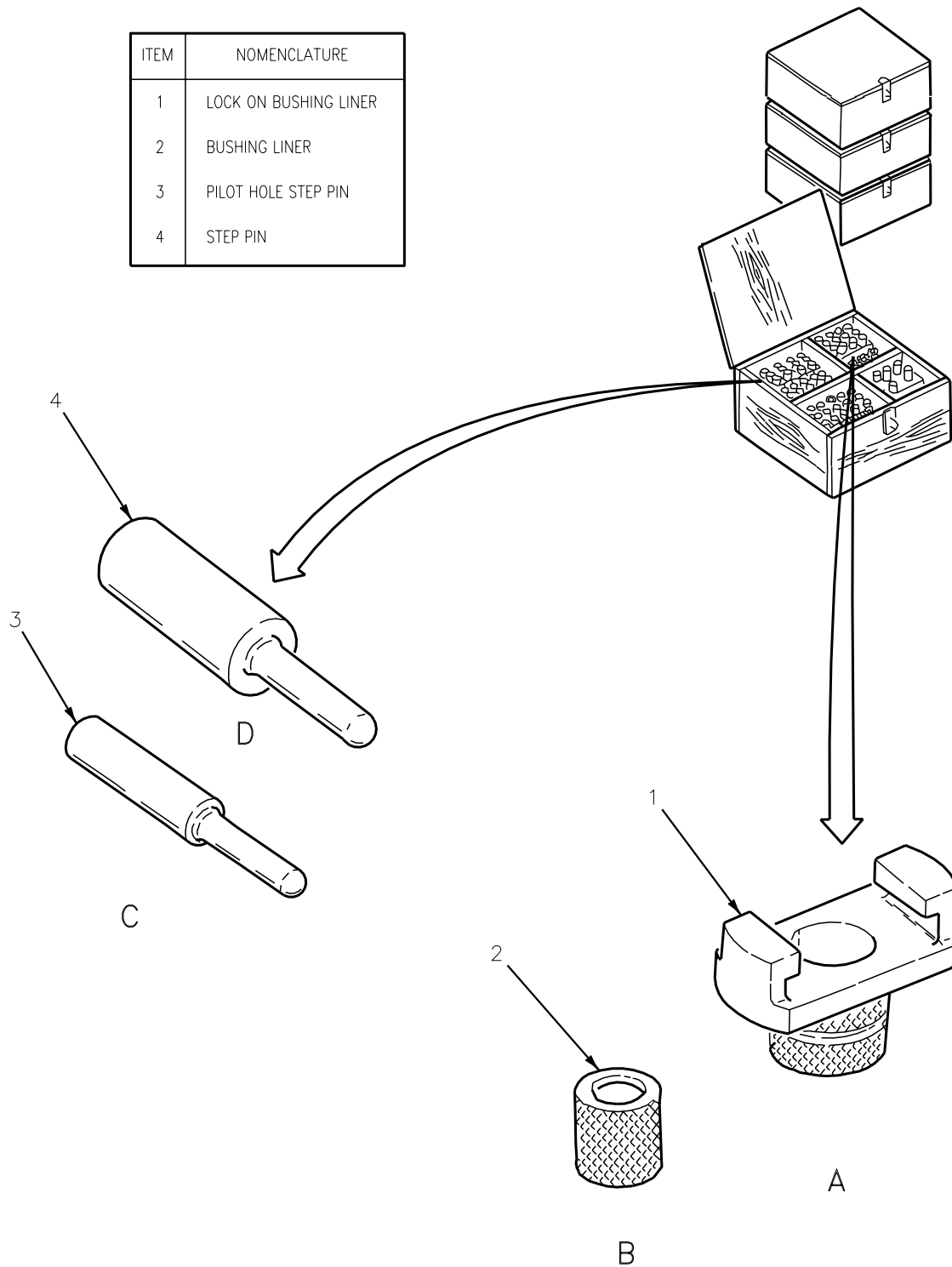
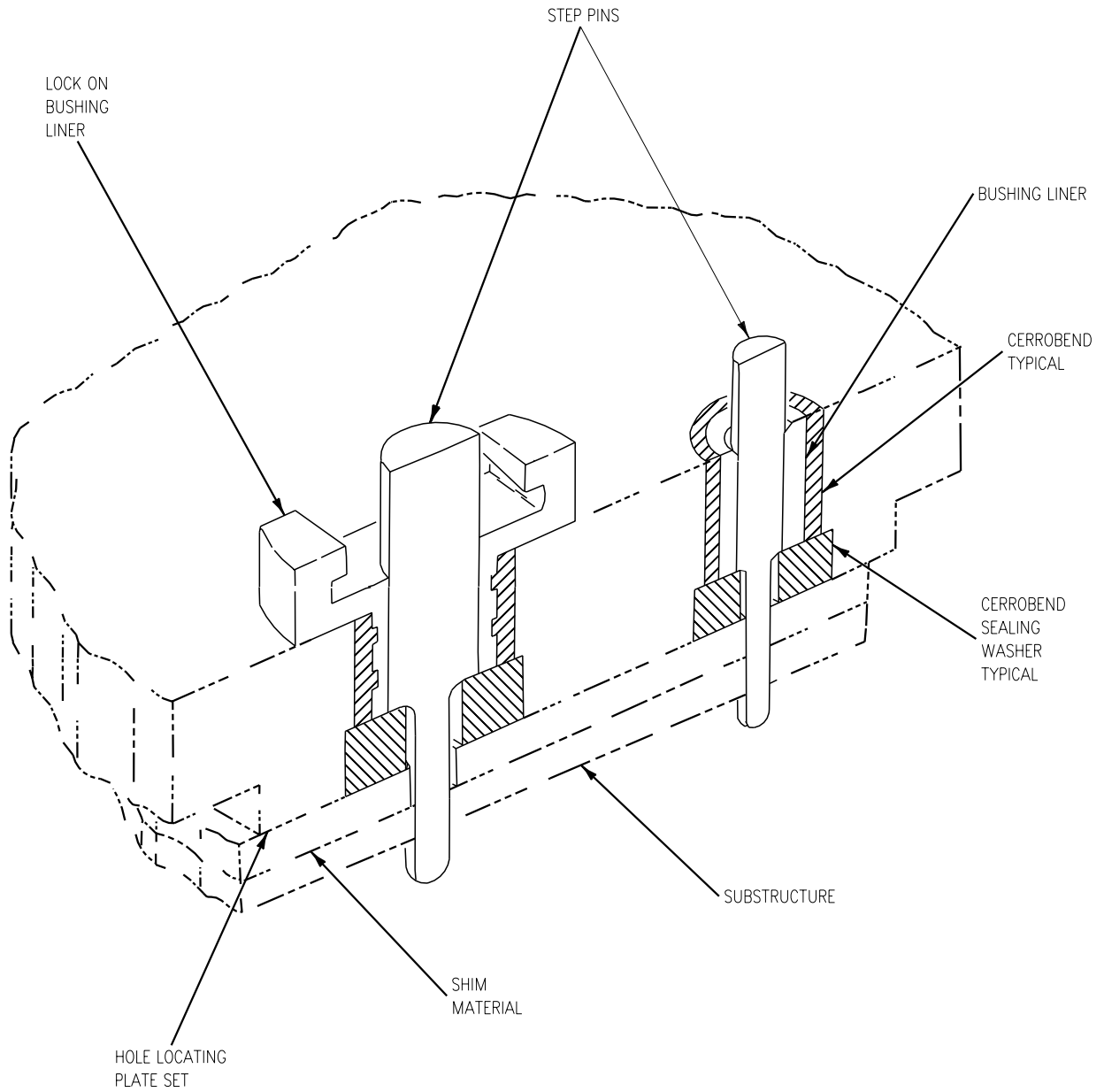
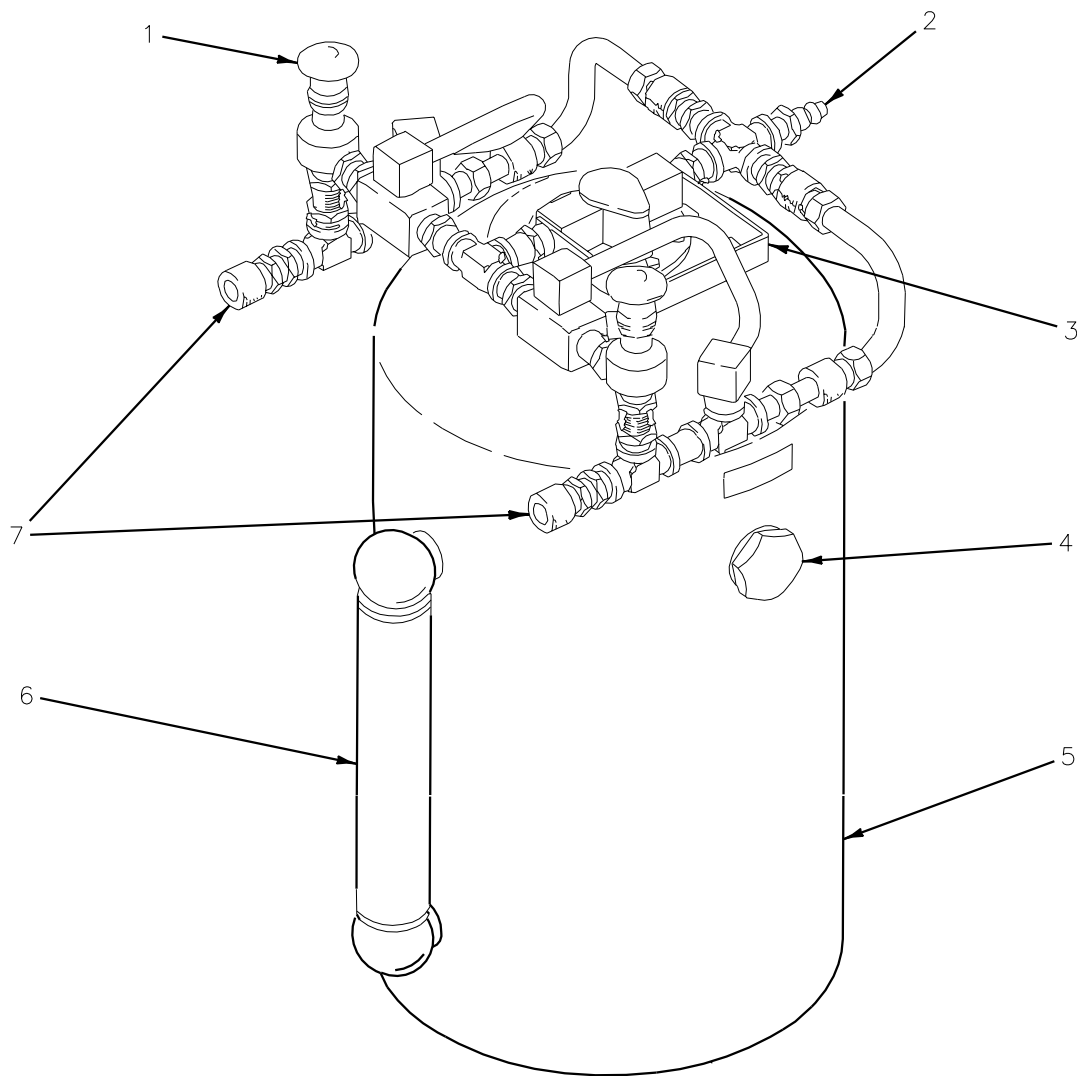


Figure 2. Hole Locating Plate Set Accessory Kit (Sheet 1)



E

Figure 2. Hole Locating Plate Set Accessory Kit (Sheet 2)







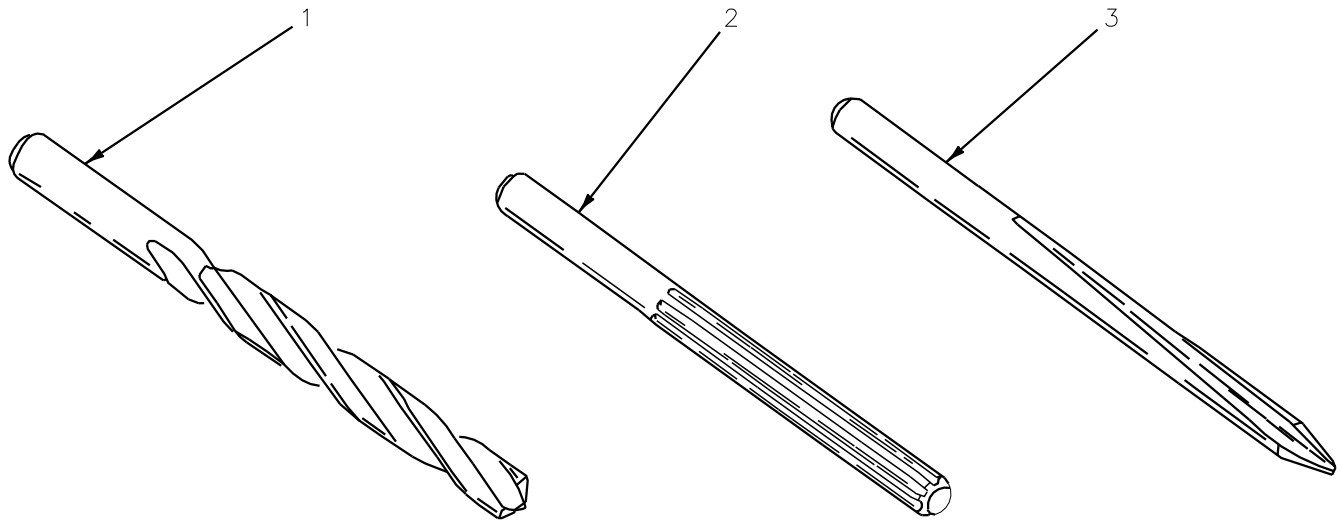
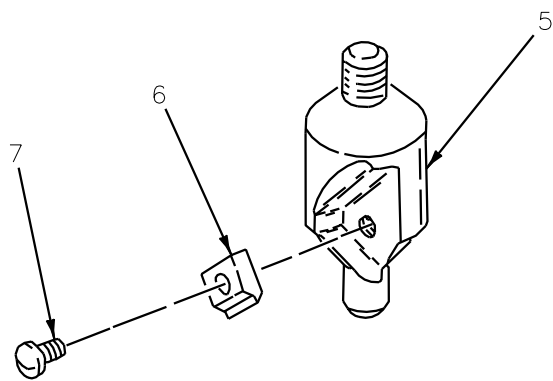
ITEM	NOMENCLATURE
1	ADJUSTABLE FLOW VALVE
2	QUICK DISCONNECT, MALE 
3	HANDLE
4	FILLER
5	5 GALLON TANK
6	GAGE
7	QUICK DISCONNECT, FEMALE 
NOTES:	
	90 PSI SHOP AIR PRESSURE
	COOLANT FLOW TO WORK

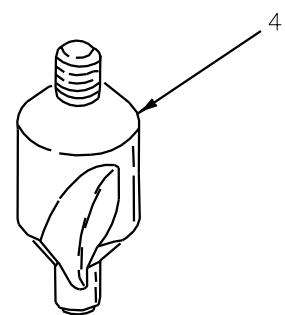
Figure 3. Spray Mist Coolant Tank Assembly



A

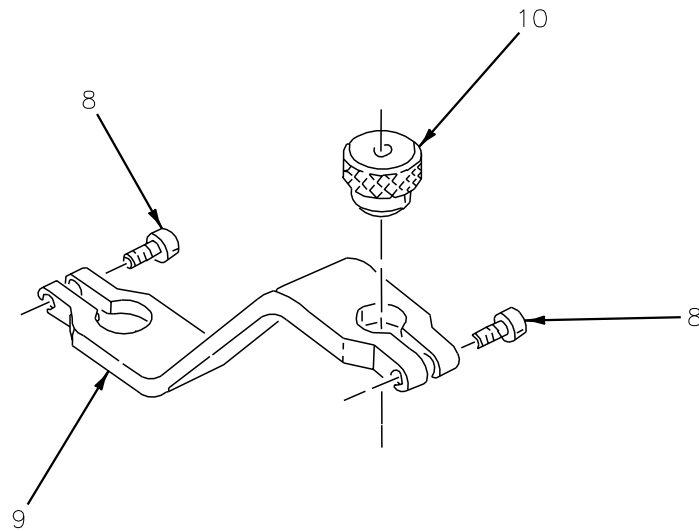


C



B

Figure 4. Aircraft Structure Repair Tool Kit (Sheet 1)



D

ITEM	NOMENCLATURE
1	TWIST DRILL
2	REAMER
3	FLAT FLUTE DRILL BIT
4	ONE PIECE COUNTERSINK
5	CARBIDE COUNTERSINK BODY
6	CARBIDE INSERT
7	CARBIDE INSERT CAM PIN
8	TRAVELER BUSHING SETSCREW
9	TRAVELER BUSHING HANDLE
10	TRAVELER BUSHING

Figure 4. Aircraft Structure Repair Tool Kit (Sheet 2)

DEPOT MAINTENANCE

STRUCTURE REPAIR

SHOP PRACTICES

DRILLING MACHINES

Reference Material

Structure Repair, General Information	A1-F18AC-SRM-200
Fastener Hole Classification Data	WP004 15
Accessory Kits and Spray Mist Coolant Tank	WP004 16

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Record of Applicable Technical Directives

None

1. **DRILLING MACHINES.** See figure 1.
2. The drilling machines information listed in this work package will assist depot personnel in setup and operation of the equipment. Selection of correct equipment and tools shall assist in meeting specified performance from close tolerance and interference fit fastener systems.

Support Equipment Required

Part Number or Type Designation	Nomenclature
74D110312-1001	Rack Feed Drilling Machine, 1000 RPM
74D110312-1003	Rack Feed Drilling Machine, 180 RPM
74D110312-1005	Rack Feed Drilling Machine, 150 RPM
74D110313-1001	Hydraulic Feed Drilling Machine, 265 RPM
74D110311-1001	Hydraulic Feed Drilling Machine, 800 RPM
74D110314-1001	Positive Feed Drilling Machine, 1100 to 450 RPM
74D110314-1003	Positive Feed Drilling Machine, 640 to 265 RPM
74D110314-1009	Positive Feed Drilling Machine, 250 RPM
74D110314-1007	Positive Feed Right Angle Drilling Machine, 140 RPM
74D110314-1005	Positive Feed Drilling Machine, 110 RPM
74D110316-1001	Hydro Check Feed Drilling Machines, 500 and 2000 RPM

Materials Required

None

3. RACK FEED DRILLING MACHINE, 1000 RPM.

4. The rack feed drilling machine, 1000 RPM (1000 RPM drilling machine) provides required cutter feed and speed control for countersinking all classes of 3/8, 7/16, and first and second oversize fastener holes in graphite epoxy. The 1000 RPM drilling

machine is also used for drilling 2.670, 3.100, and 3.500 inches diameter inner wing pylon installation holes in graphite epoxy. The 1000 RPM drilling machine interfaces with nose adapters and coolant bushings of the drilling machines accessory kit (WP004 16).

5. PROCEDURES.

a. Equipment setup.

- (1) Select correct nose adapter.
- (2) Install nose adapter on 1000 RPM drilling machine.
- (3) Select correct coolant bushing.
- (4) Install coolant bushing on nose adapter.
- (5) Select correct cutter, reamer, twist drill, or countersink.
- (6) Install cutter in 1000 RPM drilling machine.
- (7) Connect spray mist coolant supply hose to nose adapter.
- (8) Adjust spray mist coolant flow.
- (9) Secure 1000 RPM drilling machine to lock on bushing liner on drill plate.

b. Equipment operation.

- (1) Turning geared hand feed advances drilling unit through a reduction gear giving operator absolute control over feed pressure.
- (2) An adjustable cam automatically switches on air at a predetermined setting and shuts off air on return stroke.
- (3) Stroke length can be adjusted to maximum of 4 inches using hex wrench.

c. Fabricate holes as specified in specific structure repair series manuals A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750.

6. RACK FEED DRILLING MACHINE, 180 RPM.

7. The rack feed drilling machine, 180 RPM (180 RPM drilling machine) provides required cutter

feed and speed control for countersinking all classes of 3/8, 7/16, and first and second oversize fastener holes in titanium. The 180 RPM drilling machine is also used to drill and ream 0.500 and 1.000 inch diameter holes in titanium clevises and beryllium copper bushings. The 180 RPM drilling machine interfaces with the drilling machines accessory kit (WP004 16).

8. PROCEDURES.

a. Equipment setup.

- (1) Select correct nose adapter.
- (2) Install nose adapter on 180 RPM drilling machine.
- (3) Select correct coolant bushing.
- (4) Install coolant bushing on nose adapter.
- (5) Select correct cutter; reamer, twist drill, or countersink.
- (6) Install cutter in 180 RPM drilling machine.
- (7) Connect spray mist coolant supply hose to adapter.
- (8) Adjust spray mist coolant flow.
- (9) Secure 180 RPM drilling machine to lock on bushing liner on drill plate.

b. Equipment operation.

- (1) Turning geared hand feed advances drilling unit through a reduction gear giving operator absolute control over feed pressure.
- (2) An adjustable cam automatically switches on air at a predetermined setting and shuts off air on the return stroke.
- (3) Stroke length can be adjusted to maximum of 4-1/2 inches using hex wrench.

c. Fabricate holes as specified in specific structure repair series manuals A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750.

9. RACK FEED DRILLING MACHINE, 150 RPM.

10. The rack feed drilling machine, 150 RPM (150 RPM drilling machine) provides required cutter feed and speed control for reaming first and second oversize holes in transmission attach lugs. The 150 RPM drilling machine is used to ream repair bushings in inner and outer wing fold rib, inner and outer wing forward spar, and inboard and outboard leading edge flap spar. The 150 RPM drilling machine is also used for drilling and reaming nominal holes in transmission attach lugs and ream nominal bushings in replacement of inner and outer wing forward spar. The 150 RPM drilling machine interfaces with the drilling machines accessory kit (WP004 16).

11. **PROCEDURES.** Position component to be repaired in related repair fixture or tool kit.

a. Equipment setup.

- (1) Select correct nose adapter.
- (2) Install nose adapter on 150 RPM drilling machine.
- (3) Select correct coolant bushing.
- (4) Install coolant bushing on 150 RPM drilling machine.
- (5) Select correct cutter; reamer, twist drill, or countersink.
- (6) Install cutter in 150 RPM drilling machine.
- (7) Connect spray mist coolant supply hose to nose adapter.
- (8) Adjust coolant flow.
- (9) Secure 150 RPM drilling machine in repair fixture.

b. Equipment operation.

- (1) Turning geared hand feed advances drilling unit through a reduction gear giving operator absolute control over feed pressure.
- (2) An adjustable cam automatically switches on air at a predetermined setting and shuts off air on return stroke.

(3) Stroke length can be adjusted to maximum of 17 inches.

c. Fabricate holes as specified in specific structure repair series manuals A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750.

12. HYDRAULIC FEED DRILLING MACHINE, 265 RPM.

13. The hydraulic feed drilling machine, 265 RPM (265 RPM drilling machine) provides required feed and speed control for drilling and reaming of many classes of nominal and first and second oversize fastener holes. The 265 RPM drilling machine is used to drill 3/16 and 1/4 inch holes in graphite epoxy and titanium and 5/16 inch diameter holes in titanium. The 265 RPM drilling machine is used to ream 3/8 inch diameter holes in titanium 0.150 inches thick or greater and 3/16, 1/4, and 5/16 inch diameter holes in graphite epoxy. The 265 RPM drilling machine interfaces with the drilling machines accessory kit (WP004 16).

14. PROCEDURES.

a. Equipment setup.

- (1) Select correct nose adapter.
- (2) Install nose adapter.
- (3) Select correct coolant bushing.
- (4) Install coolant bushing.
- (5) Select correct twist drill or reamer.
- (6) Install twist drill or reamer in 265 RPM drilling machine.
- (7) Connect spray mist coolant supply hose to nose adapter.
- (8) Adjust spray mist coolant flow.
- (9) Secure 265 RPM drilling machine to lock on bushing liner in drill plate.

b. Equipment operation.

- (1) A hydraulic check controls the 30 to 40 seconds per inch piston feed rate on forward and aft strokes.

(2) An adjustable setscrew controls stroke length up to 2 inches maximum.

(3) At 90 psi operating pressure, thrust capacity is 170 pounds.

c. Fabricate holes as specified in specific structure repair series manuals A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750.

15. HYDRAULIC FEED DRILLING MACHINE, 800 RPM.

16. The hydraulic feed drilling machine, 800 RPM (800 RPM drilling machine) provides twist drill feed and speed control for drilling of all 3/16 and 1/4 inch, class D fastener holes in acrylic transparencies of windshield and canopies. The 800 RPM drilling machine is also used for drilling holes in transparency and framework simultaneously. The 800 RPM drilling machine interfaces with nose adapters and coolant bushings of the drilling machines accessory kit (WP004 16).

17. PROCEDURES.

a. Equipment setup.

- (1) Select correct nose adapter.
- (2) Install nose adapter on 800 RPM drilling machine.
- (3) Select correct coolant bushing.
- (4) Install coolant bushing on nose adapter.
- (5) Select correct twist drill.
- (6) Install twist drill in 800 RPM drilling machine.
- (7) Connect spray mist coolant supply hose to nose adapter.
- (8) Adjust spray coolant flow.
- (9) Secure 800 RPM drilling machine to lock on bushing liner in maintenance fixture.

b. Equipment operation.

- (1) A hydraulic check controls the 30 to 40 seconds per inch piston feed rate on forward and aft strokes.

(2) An adjustable setscrew controls stroke length up to 2 inches

(3) At 90 psi operating pressure, thrust capacity is 90 pounds.

c. Fabricate holes as specified in specific structure repair series manuals A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750.

18. POSITIVE FEED DRILLING MACHINE, 1100 TO 450 RPM.

19. The positive feed drilling machine, 1100 to 450 RPM (1100 to 450 RPM drilling machine) provides required feed and speed control for drilling all 3/8 and 7/16 diameter holes in graphite epoxy or graphite epoxy/aluminum and 7/16 diameter holes in aluminum. Cutter life control is an important feature of the 1100 to 450 RPM drilling machine; as a cutter dulls, the drill motor sensor senses increased thrust and decreases motor speed and feed. The 1100 to 450 RPM drilling machine interfaces with nose adapters and coolant bushings of the drilling machines accessory kit (WP004 16).

20. PROCEDURES.

a. Equipment setup.

(1) Select correct nose adapter.

(2) Install nose adapter on 1100 to 450 RPM drilling machine.

(3) Select correct coolant bushing.

(4) Install coolant bushing on nose adapter.

(5) Select correct twist drill.

(6) Install twist drill in 1100 to 450 RPM drilling machine.

(7) Connect spray mist coolant supply hose to nose adapter.

(8) Adjust spray mist coolant flow.

(9) Secure 1100 to 450 RPM drilling machine to lock on bushing liner on drill plate.

b. Equipment operation.

(1) Positive mechanical feed causes fixed rate advance of 0.002 inch per revolution.

(2) Stroke length can be adjusted to maximum of 4 inches by rotating knurled collar on 1100 to 450 RPM drilling machine body.

(3) Spindle automatically returns to start position at end of feed stroke.

c. Fabricate holes as specified in specific structure repair series manuals A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750.

21. POSITIVE FEED DRILLING MACHINE, 640 TO 265 RPM.

22. The positive feed drilling machine, 640 to 265 RPM (640 to 265 RPM drilling machine) provides required feed and speed control for drilling all holes larger than 3/16 inch diameter in graphite epoxy/titanium and all holes larger than 5/16 inch diameter in titanium. Cutter life control is an important feature of the 640 to 265 RPM drilling machine; as a cutter dulls, the drill motor sensor senses increased thrust and decreases motor speed and feed. The 640 to 265 RPM drilling machine interfaces with nose adapters and coolant bushings of the drilling machines accessory kit (WP004 16).

23. PROCEDURES.

a. Equipment setup.

(1) Select correct nose adapter.

(2) Install nose adapter on 640 to 265 RPM drilling machine.

(3) Select correct coolant bushing.

(4) Install coolant bushing on nose adapter.

(5) Select correct twist drill (WP004 15).

(6) Install twist drill in 640 to 265 RPM drilling machine.

(7) Connect spray mist coolant supply hose to nose adapter.

(8) Adjust spray mist coolant flow.

(9) Secure 640 to 265 RPM drilling machine to lock on bushing liner in drill plate.

b. Equipment operation.

(1) Positive mechanical feed causes fixed rate advance of 0.002 inch per revolution.

(2) Stroke length can be adjusted to maximum of 4 inches by rotating knurled collar on 1100 to 450 RPM drilling machine body.

(3) Spindle automatically returns to start position at end of feed stroke.

c. Fabricate holes as specified in specific structure repair series manuals A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750.

24. POSITIVE FEED DRILLING MACHINE, 250 RPM.

25. The positive feed drilling machine, 250 RPM (250 RPM drilling machine) provides required feed and speed control for drilling and reaming many classes of nominal and first and second oversize fastener holes. The 250 RPM drilling machine is used to drill and ream 3/8 and 7/16 inch diameter fastener holes in graphite epoxy skins of inner or outer wings with aluminum or titanium substructure. The 250 RPM drilling machine is used to drill 7/16 inch diameter holes in aluminum or titanium skins or substructure of inner wings and aluminum or titanium substructure of vertical stabilizer. The 250 RPM drilling machine is used on arresting hook support and mating aluminum substructure with 7/16 inch diameter fastener holes. The 250 RPM drilling machine interfaces with nose adapters and coolant bushings of the drilling machines accessory kit (WP004 16).

26. PROCEDURES.

a. Equipment setup.

(1) Select correct nose adapter.

(2) Install nose adapter on 250 RPM drilling machine.

(3) Select correct coolant bushing.

(4) Install coolant bushing on nose adapter.

(5) Select correct twist drill or reamer.

(6) Install twist drill or reamer in 250 RPM drilling machine.

(7) Connect spray mist coolant supply hose to nose adapter.

(8) Adjust spray mist coolant flow.

(9) Secure 250 RPM drilling machine to lock on bushing liner in drill plate.

b. Equipment operation.

(1) Positive mechanical feed causes fixed rate advance of 0.006 inch per revolution.

(2) Stroke length can be adjusted to maximum of 4 inches by rotating knurled collar on 250 RPM drilling machine body.

(3) Spindle automatically returns to start position at end of feed stroke.

c. Fabricate holes as specified in specific structure repair series manuals A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750.

27. POSITIVE FEED DRILLING MACHINE, RIGHT ANGLE, 140 RPM.

28. The positive feed drilling machine, right angle, 140 RPM (140 RPM right angle drilling machine) provides required feed and speed control for repair of engine bay door former segments and droplinks. The 140 RPM right angle drilling machine is used to precision machine nominal holes in replacement droplink bushings and for first and second oversize holes in droplinks. The 140 RPM right angle drilling machine interfaces with the engine bay door droplink drill jig.

29. PROCEDURE.

a. Equipment setup.

(1) Select correct nose piece.

(2) Install nose piece on 140 RPM right angle drilling machine.

(3) Connect 140 RPM right angle drilling machine to required drill jig.

(4) Select correct cutters; reamers/boring tools.

(5) Install cutter.

b. Equipment operation.

(1) Positive mechanical feed allows a fixed rate spindle advancement of 0.002 inch per revolution.

(2) Stroke length can be adjusted to maximum length of 6 inches.

(3) Spindle automatically returns to start position at end of feed stroke.

c. Fabricate holes as specified in specific structure repair series manuals A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750.

30. POSITIVE FEED DRILLING MACHINE, 110 RPM.

31. The positive feed drilling machine, 110 RPM (110 RPM drilling machine) provides required feed and speed control for drilling, boring, or reaming. The 110 RPM drilling machine is used to drill and ream nose landing gear attach points in replacement drag brace or trunnion support and to ream and spotface replacement nose landing gear trunnion and drag brace bushings. It is used to drill and ream replacement number 2 spar. The 110 RPM drilling machine is used to bore/ream wing attach lugs and bushings and to ream fuselage wing attach bulkheads and replacement bushings. The 110 RPM drilling machine is also used to ream inner and outer wing fold rib lugs and bushings and to bore replacement wing pylon bushings. The 110 RPM drilling machine interfaces with required tools and equipment to do required close tolerance hole fabrication.

32. PROCEDURE.

a. Equipment setup.

(1) Select correct nose assembly.

(2) Install nose assembly on 110 RPM drilling machine.

(3) Select correct cutter; drill, reamer, boring tool.

(4) Install cutter in 110 RPM drilling machine.

(5) Support 110 RPM drilling machine as required.

(6) Connect nose assembly to required fixture/tool set.

b. Equipment operation.

(1) Positive mechanical feed allows fixed feed rate of 0.006 inch per revolution.

(2) A hand wheel at rear of tool with two position gear case allows manual feed rates of 0.010 inch and 1.25 inches of advance per revolution. The spindle may be advanced to work using hand wheel. Automatic positive feed may also be engaged.

(3) At end of stroke, spindle is returned to start position by turning hand wheel.

(4) The 110 RPM drilling machine has maximum stroke length of 7.5 inches.

(5) Heavy duty dual motors create maximum of 3 horsepower.

(6) Automatic clutch protects motors and provides extended cutter life.

c. Fabricate holes as specified in specific structure repair series manuals A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750.

33. HYDRO CHECK FEED DRILLING MACHINES, 500 AND 2000 RPM.

34. The hydro check feed drilling machines, 500 and 2000 RPM (500 and 2000 RPM drilling machines) provide required feed and speed control for drilling, reaming, and countersinking. The 500 and 2000 RPM drilling machines are recommended for machining all classes of 3/32, 1/8, 5/32, 3/16, 1/4, and 5/16 inch diameter fastener holes in graphite epoxy with or without aluminum substructure. The 500 and 2000 RPM drilling machines interface with nose adapters and coolant bushings of the drilling machines accessory kit (WP004 16).

35. PROCEDURES.

a. Equipment setup.

(1) Select correct aline-a-drill hydro check yoke (yoke).

(2) Install yoke on 500 or 2000 RPM drilling machine.

drilling - 2000 RPM drilling machine.
reaming - 500 RPM drilling machine.

(3) Select correct coolant bushing.

(4) Install coolant bushing.

(5) Select correct twist drill or reamer (WP004 15).

(6) Install twist drill in 2000 RPM drilling machine or reamer in 500 RPM drilling machine.

(7) Connect spray mist coolant supply hose to 500 or 2000 RPM drilling machine.

(8) Adjust spray mist coolant flow.

(9) Hold tip of 500 or 2000 RPM drilling machine bushing in bushing liner in drill plate.

b. Equipment operation.

(1) The aline-a-drill hydro check yoke uses hydraulic cylinder and adjustable valve to control feed rate. Feed rate is set at 10 seconds per inch using twenty pound end load, use shot or sand bag(s).

(2) Three yokes are provided, each with different diameter hole in foot to receive bushings of various outside diameters.

(3) The 500 and 2000 RPM drilling machines use 1-5/8 inch diameter pressure foot adapters.

(4) The 1-5/8 inch diameter yoke attaches to pressure foot adapter on applicable drill motor and allows stroke capacity of 2 inches maximum.

c. Fabricate holes as specified in specific structure repair series manuals A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750.

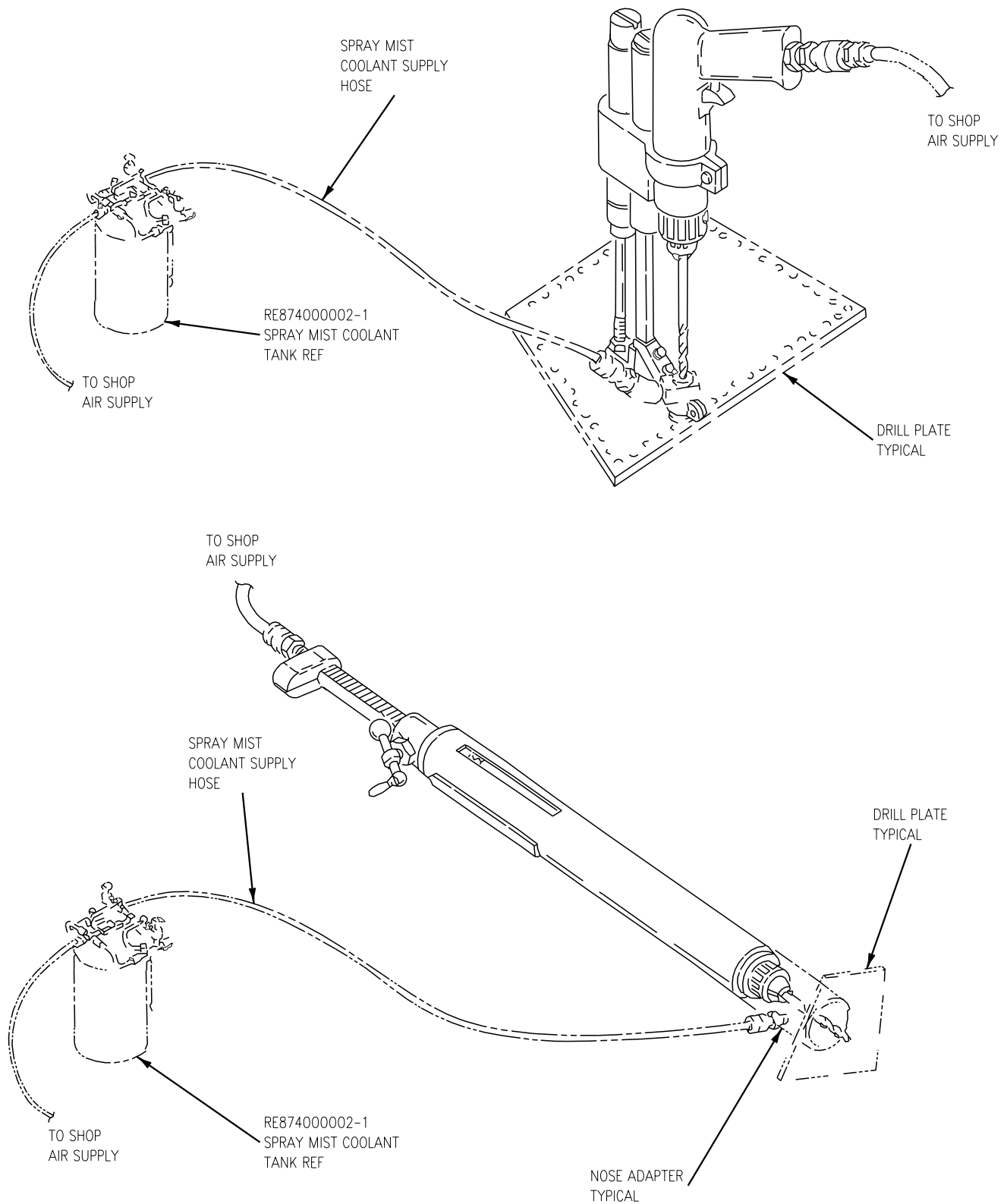


Figure 1. Typical Drilling Machine Setup (Sheet 1)

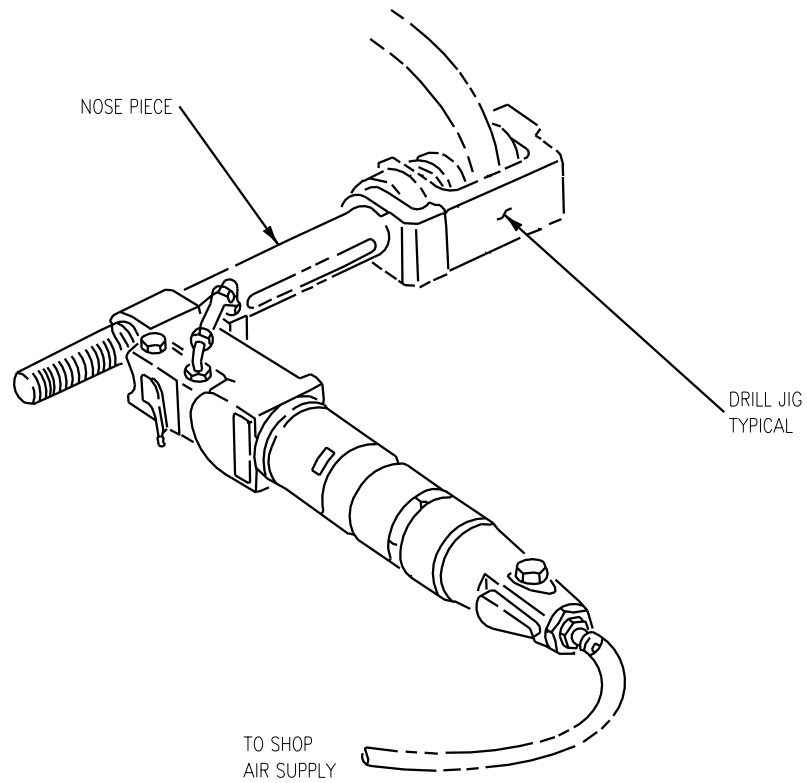


Figure 1. Typical Drilling Machine Setup (Sheet 2)

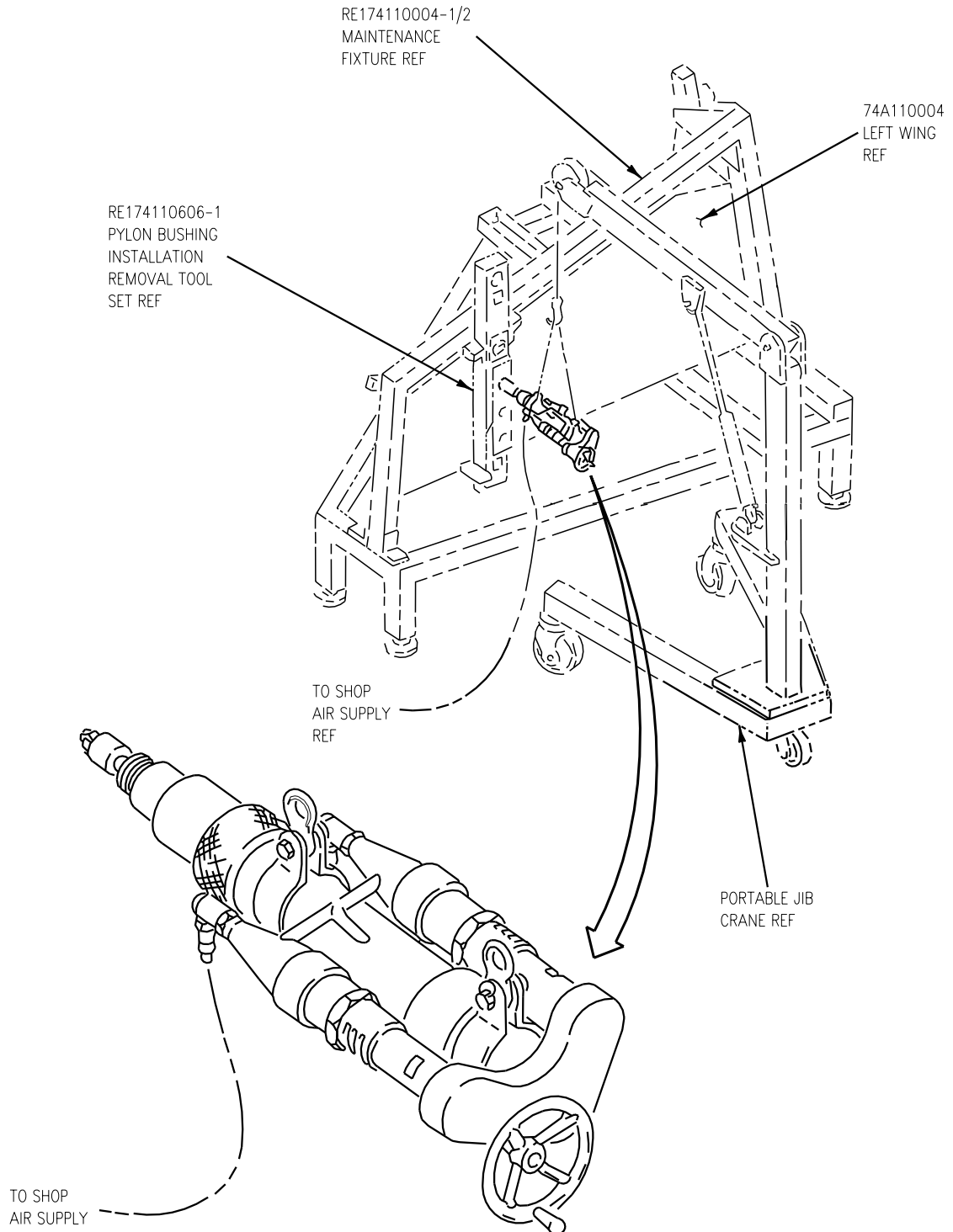


Figure 1. Typical Drilling Machine Setup (Sheet 3)

DEPOT MAINTENANCE

STRUCTURE REPAIR

SHOP PRACTICES

HYDRAULIC PUMP ASSEMBLY, PNEUMATIC

PART NO. 74D110323-1001

Reference Material

None

Alphabetical Index

Subject	Page No.
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Procedures	2
Cold Working Holes or Force Mate Bushing Installation	2
Force Mated Bushing Removal	2

Record of Applicable Technical Directives

None

1. HYDRAULIC PUMP ASSEMBLY, PNEUMATIC. See figure 1.

2. The hydraulic pump assembly, pneumatic, (hydraulic pump assembly) is pneumatically operated and will provide up to 10,000 psi working pressure. The hydraulic pump assembly is used for cold working holes, to force mate bushings in holes, and to remove force mated bushings. The hydraulic pump assembly interfaces with various hydraulic cylinders, cold working tools, a nose landing gear fixture, and wing/fuselage attach bushing tools.

3. GENERAL INFORMATION.

a. Hydraulic pump (1) pneumatically operated and will provide 10,000 psi working pressure.

b. Petcock valve (2) installed on top of reservoir to allow ventilation and prevent pump cavitation.

c. Hydraulic/pneumatic hose assemblies (3) allow hydraulic pump assembly to be connected to required hydraulic cylinder.

d. Reservoir (4) holds 80 cubic inches of fluid for use.

e. Remote control (5) has advance and retract switches and 15 foot power cable to allow operator to support nose assembly or cylinder.

f. Quick disconnect (6) for connection of 90 psi shop air.

4. PROCEDURES.

Support Equipment Required

Part Number or Type Designation	Nomenclature
74D110323-1001	Hydraulic Pump Assembly, Pneumatic

Materials Required

None

5. Cold Working Holes or Force Mate Bushing Installation.

- Position split sleeve for cold working or bushing installation into prepared hole.
- Slide mandrel through hole.
- Secure nose assembly and hydraulic cylinder.
- Install hydraulic/pneumatic hose assemblies (3) from hydraulic pump assembly to applicable port(s) on required hydraulic cylinder.

e. Connect 90 psi shop air to quick disconnect (6) on hydraulic pump assembly.

f. Depress advance switch on remote control (5) to cold work hole or mate fit bushing.

g. Depress retract switch on remote control (5) to return the cylinder.

6. Force Mated Bushing Removal.

- Position applicable removal tool(s).
- Secure required nose assembly and hydraulic cylinder.
- Install hydraulic/pneumatic hose assembly (3) from hydraulic pump assembly to applicable port(s) on hydraulic cylinder.
- Connect 90 psi shop air to quick disconnect (6) on hydraulic pump assembly.
- Depress advance switch on remote control(s) to hydraulically remove force mated bushing from lug or bulkhead.
- Depress retract switch on remote control (5) to return the cylinder.

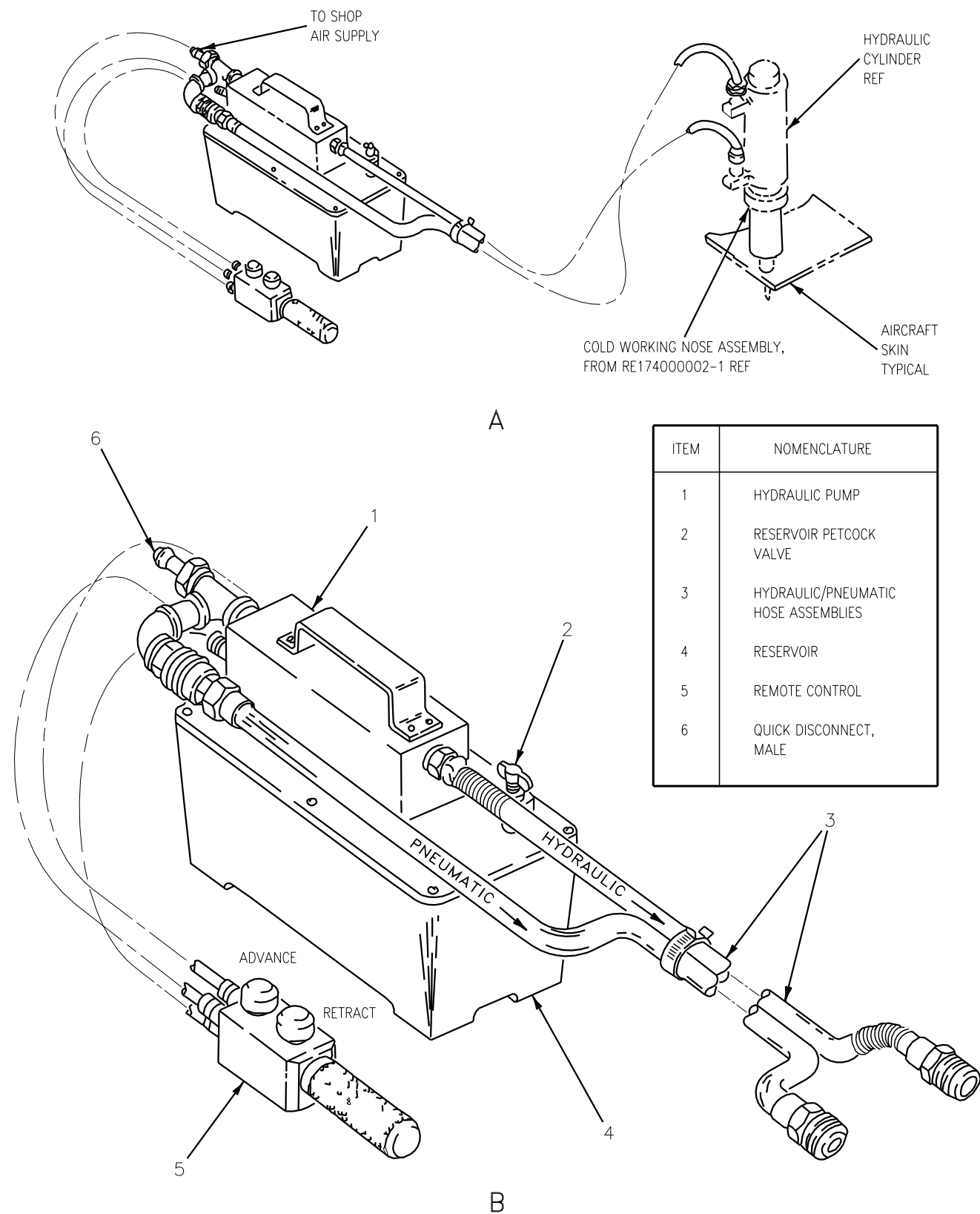


Figure 1. Hydraulic Pump Assembly, Pneumatic

DEPOT MAINTENANCE**STRUCTURE REPAIR****SHOP PRACTICES****HYDRAULIC CYLINDER, 30 TON, 6 INCH STROKE****PART NUMBER RCH306****Reference Material**

None

Alphabetical Index

Subject	Page No.
Hydraulic Cylinder, 30 Ton, 6 Inch Stroke, RCH306	1
Procedure	1

Record of Applicable Technical Directives

None

1. HYDRAULIC CYLINDER, 30 TON, 6 INCH STROKE, RCH306. See figure 1.

2. The hydraulic cylinder, 30 ton, 6 inch stroke, RCH306 (hydraulic cylinder) interfaces with tools or kits required for cold working and for bushing removal or installation.

3. PROCEDURES.

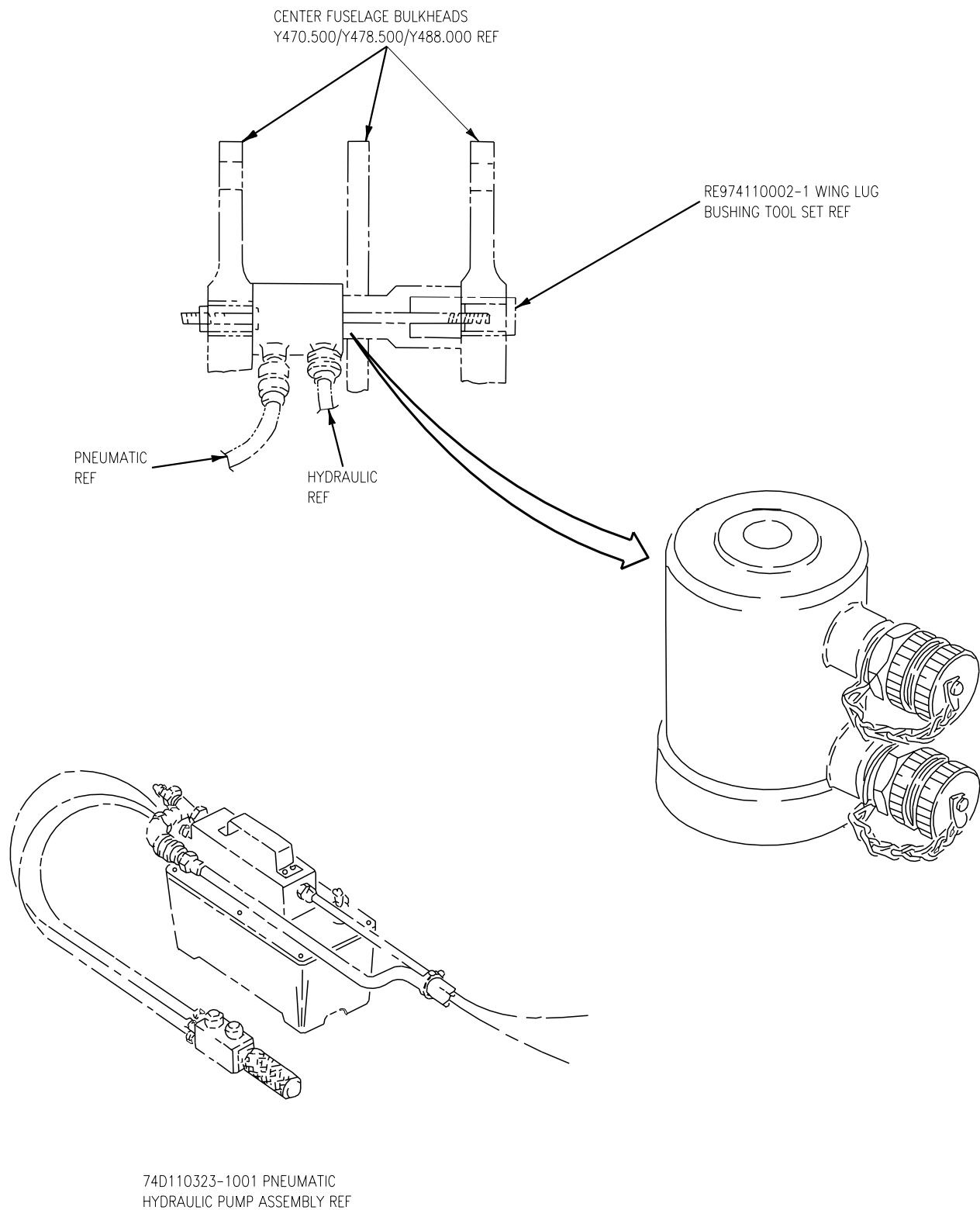
- a. Position hydraulic cylinder.
- b. Install required fixture(s) or attachment(s).
- c. Connect pneumatic, hydraulic pump assembly to hydraulic cylinder.
- d. Connect shop air to pneumatic, hydraulic pump assembly.
- e. Actuate hydraulic cylinder by pushing ADVANCE on remote control.
- f. Retract hydraulic cylinder by pushing RETRACT on remote control.

Support Equipment Required

Part Number or Type Designation	Nomenclature
74D110323-1001	Hydraulic Pump Assembly, Pneumatic

Materials Required

None



**Figure 1. Hydraulic Cylinder, 30 Ton, 6 Inch Stroke,
RCH306**

DEPOT MAINTENANCE

STRUCTURE REPAIR

SHOP PRACTICES

COLD WORKING FASTENER HOLE TOOL SET

PART NO. RE174000002-1

Reference Material

Structure Repair, General Information	A1-F18AC-SRM-200
Accessory Kits and Spray Mist Coolant Tank	WP004 16
Cold Working Fastener Holes	WP004 10
Hydraulic Pump Assembly, Pneumatic	WP004 18

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Subject	Page No.
Cold Working Fastener Hole Tool Set	1
Procedures	1
Force Mate Cold Working	4
Split Sleeve Cold Working	2
Stress Coin Cold Working	3

Record of Applicable Technical Directives

None

1. COLD WORKING FASTENER HOLE
TOOL SET.

3. PROCEDURES. See figures 1 and 2.

2. The cold working fastener hole tool set is used on F/A-18 aircraft to improve fatigue life of fastener holes in metals. The tool set is used in three procedures; split sleeve cold working for holes, stress coining for holes and countersinks, and force mate cold working.

Support Equipment Required

Part Number or Type Designation	Nomenclature
74D110325-1001	Aircraft Structure Repair Tool Kit
74D110323-1001	Pneumatic Hydraulic Pump Assembly
RD93	Hydraulic Cylinder
AVC-13A1	Rivet Gun
Jiffy 600	Rivet Gun

Materials Required

Specification or Part Number	Nomenclature
MACCO 472 —	Lubricating Oil Bucking Bar, Rubber Coated
MIL-C-87962, TYPE 1	Cleaning Cloth

4. Split Sleeve Cold Working. Split sleeve cold working uses disposable, pre-lubricated split sleeves and tapered mandrels to make a compressed pre-stressed zone around a hole(s) resulting in increased fatigue life of processed parts. Success of this process depends on correct hole preparation and dimensional control of split sleeves and mandrels. Split sleeve cold working is divided into two types; type 1 for fastener holes and type 2 for lug holes.

- a. Type 1, fastener holes (WP004 10).

NOTE

Previously cold worked holes need not be re-cold worked up to 1/64 inch over hole size. Second oversize shall require re-cold working using larger mandrel, split sleeve, and inspection gage.

- (1) Select correct twist drill (WP004 16).
- (2) Drill hole to correct pre-cold worked size.
- (3) Select correct reamer (WP004 16).
- (4) Ream drilled hole to correct pre-cold work size. Pre-cold work size remains constant for given diameter even if hole class differs.
- (5) Select correct inspection gage.
- (6) Inspect hole using inspection gage.
- (7) Select correct nose assembly.
- (8) Select correct mandrel.
- (9) Select mandrel retainer.
- (10) Select correct anvil.

- (11) Select correct split sleeve.

(12) Assemble nose assembly, mandrel, mandrel retainer, anvil, and split sleeve on RD93 hydraulic cylinder.

(13) Connect pneumatic hydraulic pump assembly to hydraulic cylinder (WP004 18).

(14) Insert mandrel and split sleeve into prepared hole.

(15) Actuate hydraulic cylinder using hydraulic pump. This cold works hole.

(16) Remove and discard used split sleeve.

(17) Inspect cold worked hole using same inspection gage as substep (5).

(18) Select correct reamer (WP004 16).

(19) Ream cold worked hole to correct size.

- b. Type 2, lug holes.

NOTE

Previously cold worked holes need not be re-cold worked up to 1/64 inch over hole size. Second oversize shall require re-cold working using larger mandrel, split sleeve, and inspection gage.

- (1) Select correct twist drill (WP004 16).
- (2) Drill hole to correct size.
- (3) Select correct reamer (WP004 16).
- (4) Ream drilled hole to pre-cold work size. Pre-cold work size remains constant for given diameter even if hole class differs.
- (5) Select correct inspection gage.
- (6) Inspect hole using inspection gage.
- (7) Select correct nose assembly.
- (8) Select correct mandrel.
- (9) Select correct anvil.
- (10) Select correct split sleeve.

(11) Assemble nose assembly, mandrel, anvil, and split sleeve on RD93 hydraulic cylinder.

(12) Connect pneumatic hydraulic pump assembly to hydraulic cylinder (WP004 18).

(13) Insert mandrel and split sleeve into prepared hole.

(14) Actuate hydraulic cylinder using hydraulic pump. This cold works hole.

(15) Remove and discard used split sleeve.

(16) Inspect cold worked hole using same inspection gage as substep (5).

(17) Select correct reamer (WP004 16).

(18) Ream cold worked hole to correct size.

5. Stress Coin Cold Working. Stress coin cold working uses a stress coin pin driven coaxially through fastener hole(s) by a rivet gun to make a compressed pre-stressed zone around hole(s). Countersinks are coin stressed by inserting a stress coin countersink driven by rivet gun into countersink. Countersinks are coin stressed before hole is coin stressed. Stress coining reduces distortion of parts when compared to type 1 cold working. Success of stress coining depends on correct dimensional control, cleanliness and lubrication of hole(s), and stress coin tool use.

a. Stress coining countersinks.

(1) Select correct twist drill (WP004 16).

(2) Drill hole(s) to correct size.

(3) Select correct reamer (WP004 16).

(4) Ream drilled hole to correct pre-cold work size. Pre-cold worked size remains constant for given diameter even if hole class differs.

(5) Select correct twist drill to chamfer hole (WP004 16).

(6) Chamfer hole.

(7) Select correct countersink (WP004 16).

(8) Countersink hole to correct size. Countersink cutter must have no radius at countersink to hole transition.

(9) Select correct stress coin countersink.

(10) Select correct stress coin anvil.

(11) Install stress coin countersink and stress coin anvil on rivet gun.

(a) Use AVC-13A1, Ingersol Rand rivet gun, or equivalent for 1/4 diameter or less holes.

(b) Use Jiffy 600, American Pneumatic Tool Company rivet gun, or equivalent for 5/16 diameter or larger holes.

(12) Apply lubricating oil to countersink or expander tool.

(13) Insert stress coin countersink tool into countersink.

(14) Apply slow, constant impact, with rivet gun, for minimum of 2 seconds. During this procedure opposite side of structure should be backed with rubber covered bucking bar.

(15) Clean lubricant and any metal particles from hole using cleaning cloth.

(16) Remove stress coin countersink and stress coin anvil from rivet gun.

b. Stress coining holes.

(1) Select correct stress coin pins.

(2) Select correct stress coin anvil.

(3) Install stress coin pin and stress coin anvil on rivet gun.

(4) Dip large end of stress coin pin into lubricating oil.

(5) Insert end of stress coin pin into countersink side of prepared hole.

(6) A continuous driving force is applied coaxially with rivet gun until stress coin pin is driven through hole(s) in material. During this procedure, opposite side of structure should be backed with rubber covered bucking bar.

(7) Inspect completed hole(s) for correct size.

(8) Select correct piloted reamer (WP004 16).

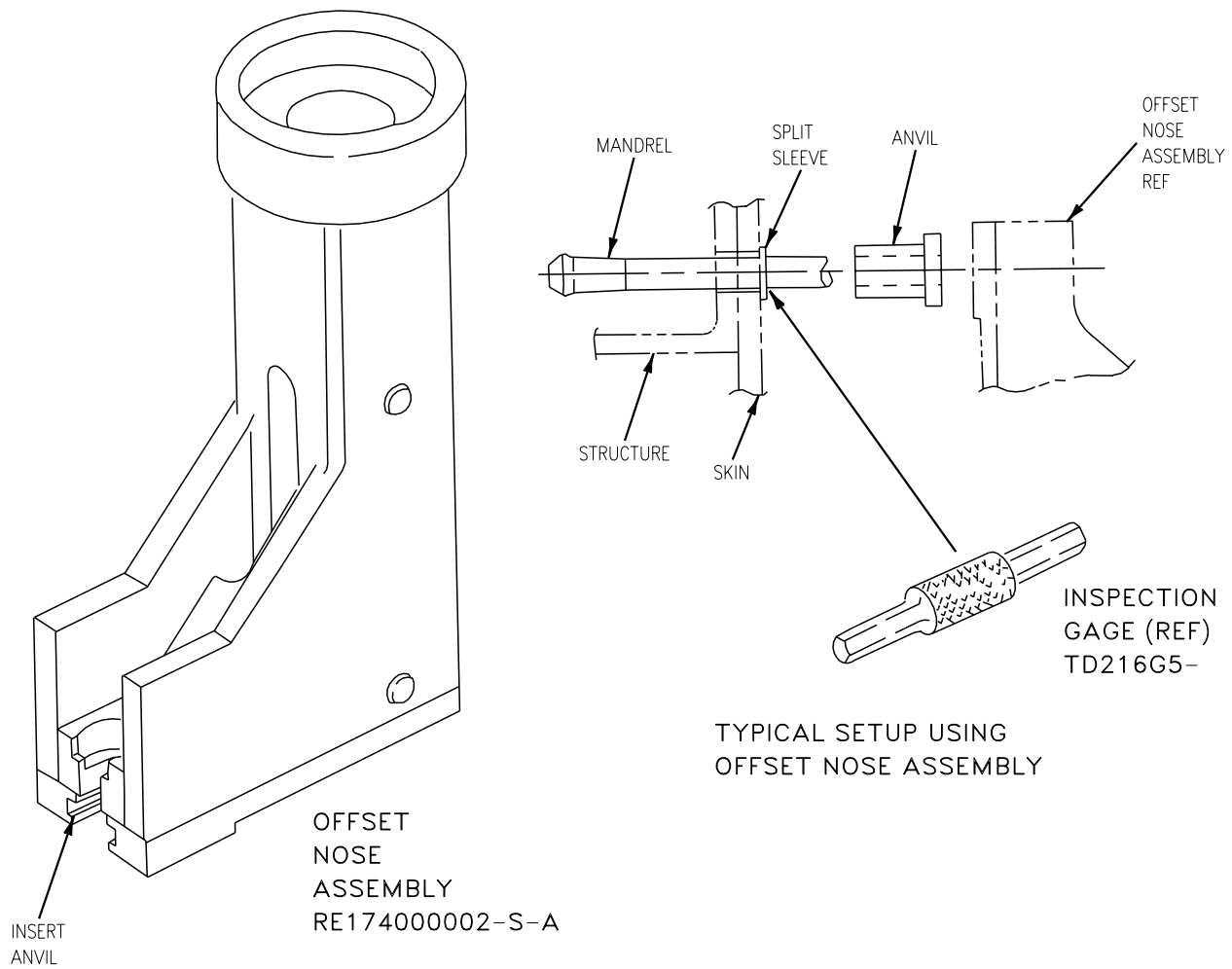
(9) Select required stress coin flex drive.

(10) Install reamer and stress coin flex drive on required drilling machine.

(11) Ream stress coined holes to correct size.

(12) Remove reamer and stress coin flex drive from drilling machine.

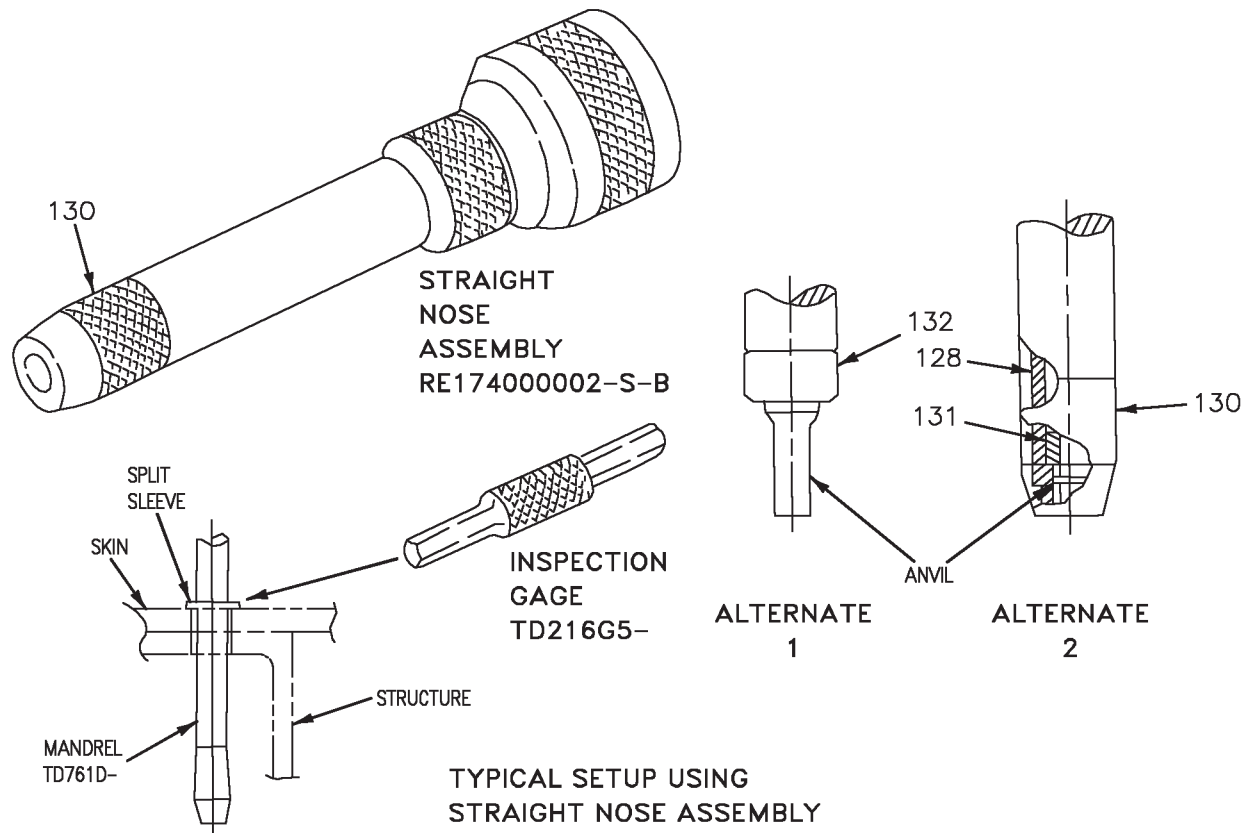
6. Force Mate Cold Working. Force mate cold working will be referenced from specific structure repair series manuals A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750. Force Mate cold working will be put into this manual when data becomes available.



SPLIT SLEEVE COLD WORKING (RE174000002-S-A)

HOLE SIZE	FLAT ANVIL OR DETAIL	ANVIL OR EXTENSION DETAIL	MANDREL TD761L-	INSPECTION GAGE TD216G5-
5/32 NOM.	144	—	050	050
FIRST OVS.	145	—	051	051
3/16 NOM.	146	135	30/30C	30
FIRST OVS.	147	136	31/31C	31
SECOND OVS.	148	137	32/32C	32
1/4 NOM.	149	138	40/40A	40
FIRST OVS.	150	139	41/41A	41
SECOND OVS.	151	140	42/42A	42
5/16 NOM.	152	141	50/50A	50
FIRST OVS.	153	142	51/51A	51
SECOND OVS.	154	143	52/52A	52

Figure 1. Cold Working Tool Set (Sheet 1)



18AC-SRM-20-(181-2)31-SCAN

SPLIT SLEEVE COLD WORKING (RE174000002-S-B)

HOLE SIZE	ALTERNATE 1 NARROW ACCESS			ALTERNATE 2			MANDREL TD761D-	INSPECTION GAGE TD216 G5-
	ANVIL EXTENSION DETAIL	OR SHORT ANVIL DETAIL	THREAD PROTECTOR DETAIL	O-RING ANVIL DETAIL	ANVIL RETAINER DETAIL	BACK UP RING DETAIL		
5/32 NOM.	—	167	132	—	—	—	050	050
FIRST OVS.	—	168	132	—	—	—	051	051
3/16 NOM.	155	169	132	—	—	—	30	30
FIRST OVS.	156	170	132	—	—	—	31	31
SECOND OVS.	157	171	132	—	—	—	32	32
1/4 NOM.	158	172	132	—	—	—	40	40
FIRST OVS.	159	173	132	—	—	—	41	41
SECOND OVS.	160	174	132	—	—	—	42	42
5/16 NOM.	161	175	132	G	130	131	50	50
FIRST OVS.	162	176	132	G	130	131	51	51
SECOND OVS.	163	177	132	G	130	131	52	52
3/8 NOM.	164	178	132	H	130	131	60	60
FIRST OVS.	165	179	132	H	130	131	61	61
SECOND OVS.	166	180	132	H	130	131	62	62
7/16 NOM.	—	—	—	J	130	131	70	70
FIRST OVS.	—	—	—	K	130	131	71	71
SECOND OVS.	—	—	—	K	130	131	72	72

Figure 1. Cold Working Tool Set (Sheet 2)

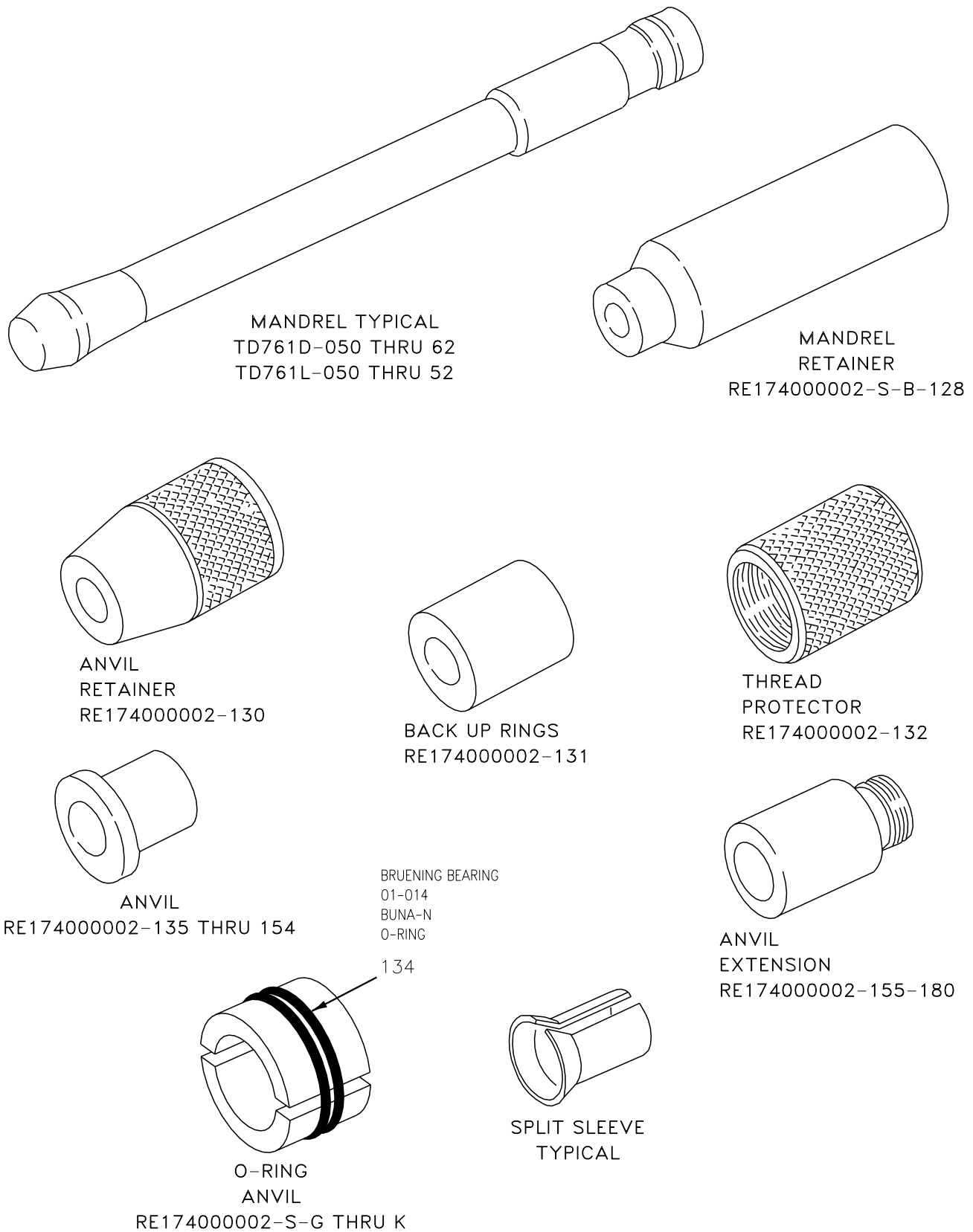
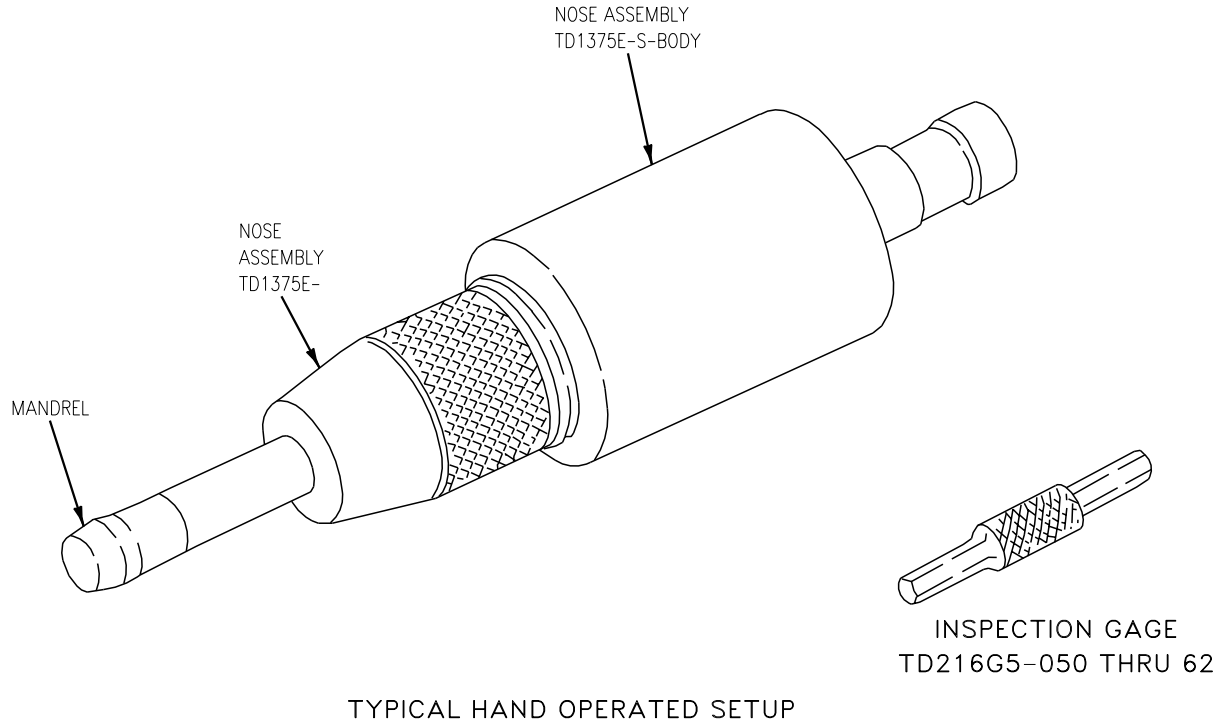


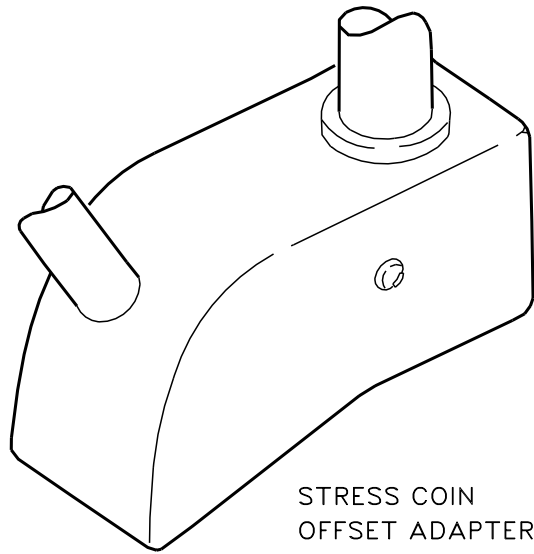
Figure 1. Cold Working Tool Set (Sheet 3)



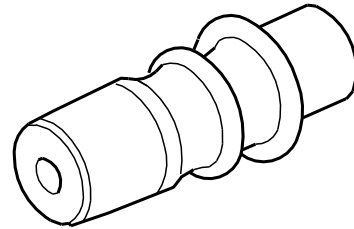
HAND OPERATED COLD WORKING NOSE ASSEMBLY TD1375E

HOLE SIZE	TD1375E- SUBASSEMBLY	MANDREL TD761D-	INSPECTION GAGE TD216G5-
5/32 NOM.	M	050	050
FIRST OVS.	N	051	051
3/16 NOM.	A	30	30
FIRST OVS.	B	31	31
SECOND OVS.	P	32	32
1/4 NOM.	C	40	40
FIRST OVS.	D	41	41
SECOND OVS.	E	42	42
5/16 NOM.	F	50	50
FIRST OVS.	G	51	51
SECOND OVS.	H	52	52
3/8 NOM.	J	60	60
FIRST OVS.	K	61	61
SECOND OVS.	L	62	62

Figure 1. Cold Working Tool Set (Sheet 4)

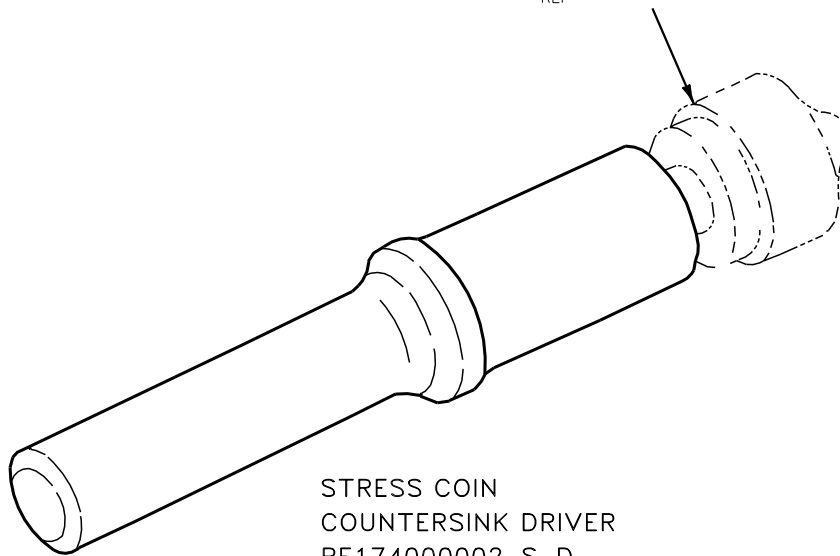


STRESS COIN
OFFSET ADAPTER
RE174000002-S-C



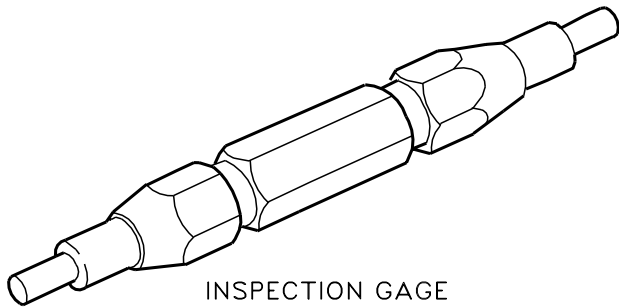
STRESS COIN PIN
RE174000002-192 THRU 198

STRESS COIN
COUNTERSINK
RE174000002-S-L THRU S
REF

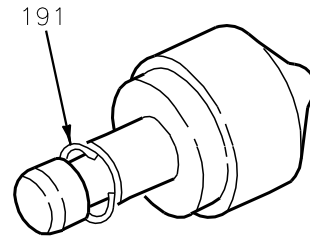


STRESS COIN
COUNTERSINK DRIVER
RE174000002-S-D

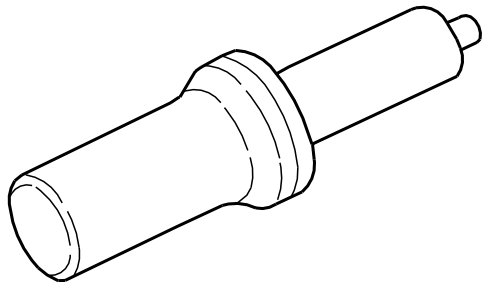
Figure 1. Cold Working Tool Set (Sheet 5)



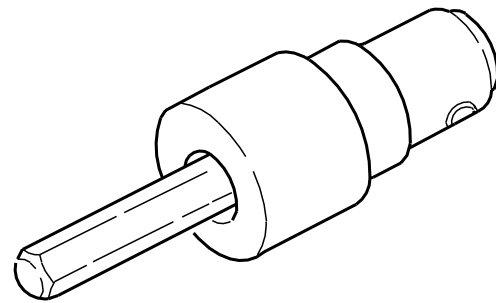
INSPECTION GAGE
RE174000002-212 THRU 214



STRESS COIN
COUNTERSINK
RE174000002-S-L THRU S



STRESS COIN ANVIL
RE174000002-S-T THRU V



STRESS COIN
FLEX DRIVE
FOR REAMER
RE174000002-S-E OR F

STRESS COINING A HOLE

HOLE SIZE	FLEX DRIVE FOR REAMER DETAIL	OFFSET ADAPTER IF REQUIRED DETAIL	STRESS COIN COUNTERSINK		STRESS COIN HOLE		
			DRIVER DETAIL	COUNTERSINK DETAIL	ANVIL DETAIL	PIN DETAIL	INSPECTION GAGE DETAIL
1/4 NOM.	E	C	D	L	U	192	212
1/4 CLASS 3	E	C	D	L	U	193	213
FIRST OVS.	E	C	D	M	U	194	214
SECOND OVS.	E	C	D	N	U	195	215
5/16 NOM.	F	C	D	P	T/V	196	216
FIRST OVS.	F	C	D	R	T/V	197	217
SECOND OVS.	F	C	D	S	T/V	198	218

Figure 1. Cold Working Tool Set (Sheet 6)

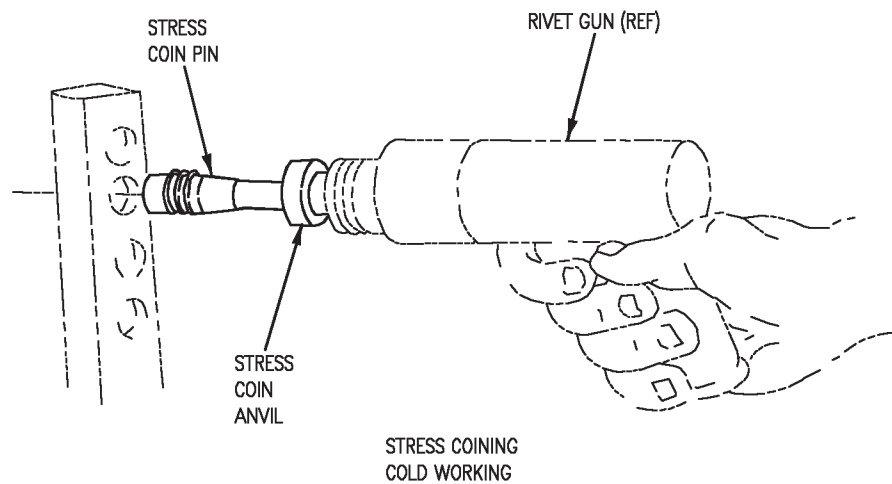
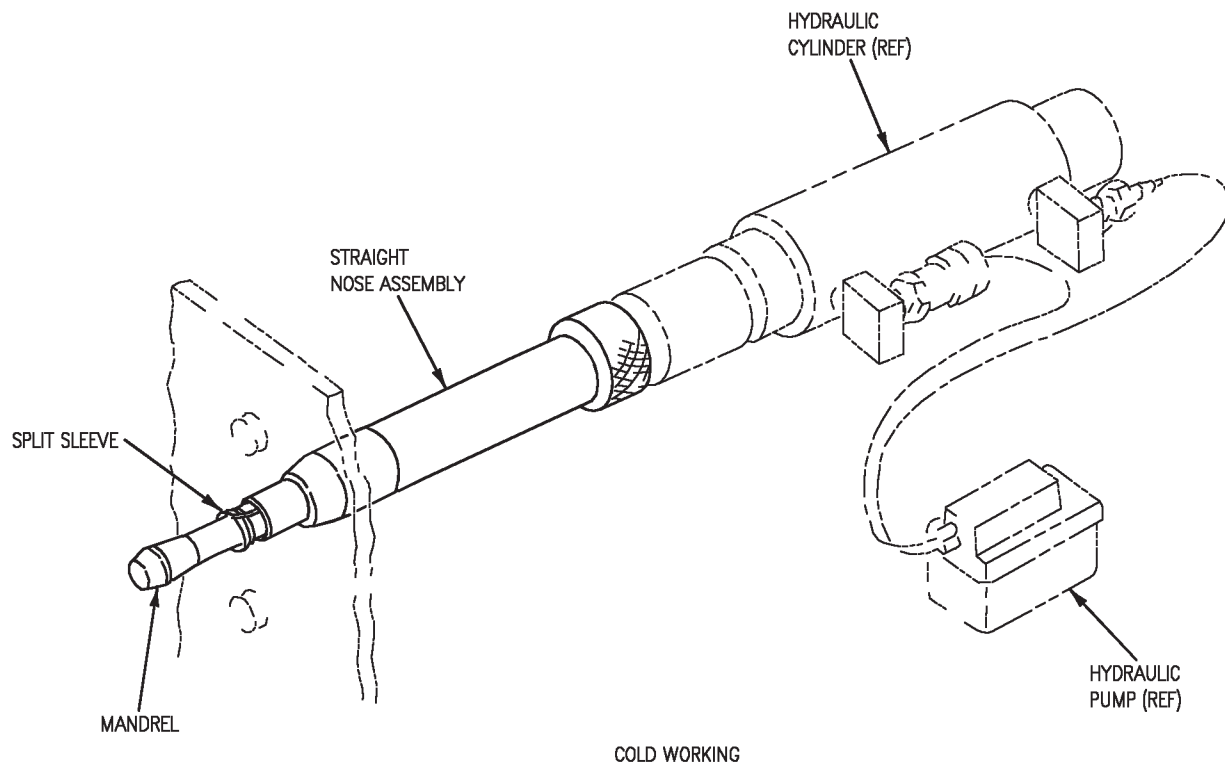


Figure 2. Typical Tool Set Up

INTERMEDIATE AND DEPOT MAINTENANCE

STRUCTURE REPAIR

SHOP PRACTICES

USE OF MIL-R-46082 RETAINING COMPOUNDS IN INSTALLATION OF BEARINGS/BUSHINGS

Reference Material

None

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Procedures.....	4
Application of Retaining Compounds.....	6
Assembly.....	6
Cleaning.....	5
Disassembly of Mated Parts After Curing.....	6
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Requirements.....	1
Application of Retaining Compounds.....	3
Cleaning.....	3
Disassembly of Parts After Curing.....	4
General.....	1
Installation.....	3
Priming.....	3

Record of Applicable Technical Directives

None

1. USE OF MIL-R-46082 RETAINING COMPOUNDS DURING ASSEMBLY OF PARTS.

2. Retaining compounds are used when installing bearings/bushings. This work package will describe how to use retaining compounds, how to prepare surfaces for retaining compounds, and how to remove and install bearings/bushings using retaining compounds.

3. REQUIREMENTS.

4. General.



a. MIL-R-46082 retaining compounds:

Type I - Single component, low viscosity, fast curing resin that may be used to fill gaps as specified in table 1. Type I has approximate room temperature shear strength of 3000 PSI and service temperature range of -65° to +300° F.

Type II - Single component, medium viscosity, higher temperature resin that may be used to fill gaps as specified in table 1. Type II has approximate room temperature shear strength of 3,000 PSI and service temperature range of -65° to +400° F.

Type III - Single component, high viscosity, higher strength resin that may be used to fill gaps as specified in table 1. Type III has approximate room temperature shear strength of 4,000 PSI and service temperature range of -65° to +300° F.

Table 1. Recommended and Maximum Permitted Gap Ranges

MIL-R-46082 Retaining Compound Type	Recommended Diametral Gap Ranges	Maximum Allowed Diametral Gaps 
I	0.0005 - 0.0035	0.005
II	0.001 - 0.004	0.007
III	0.001 - 0.004	0.010
<p>NOTE:</p> <p> Cases approaching maximum allowed gap conditions will probably require use of fixtures to maintain location and alignment within tolerances.</p>		

MIL-S-22473 Primer Grades.

Grade N - General purpose primer that may be used for all three MIL-R-46082 retaining compound types. Provides full cures in 24 hours.

Grade T - Fast curing primer that may be used for all three MIL-R-46082 retaining compound types. Provides full cures in 6 hours.

b. Before installation, all parts must meet specified requirements in specific structure repair series manuals A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750.

c. Edges of bores receiving bearings/bushings shall be broken to remove all evidence of burrs and rolled over edges. Edge break shall be from 0.005 to 0.010 inch.

d. Bearings/bushings shall, before and during installation, be protected from dirt and corrosion.

e. Mated assemblies shall meet inspection requirements specified in specific structure repair series manuals A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750 and the following:

(1) Inspect outer surface of joints using ultraviolet light. Joints not having indications of 100 percent squeeze-out shall be rejected.

(2) Assemblies not meeting location or alignment tolerances shall be rejected.

(3) Mated surfaces which can be moved, in relation to one another, by hand pressure shall be rejected.

(4) Mated parts not meeting proof load requirements, when specified, shall be rejected.

(5) Installed bearings/bushings having outer races which are not flush or below flush with surface of housing shall be rejected.

(6) Installed anti-friction ball or roller bearings shall not be bound and shall rotate without roughness. This may be done by comparing with an uninstalled bearing.

(7) Angular movement tightness of installed self-aligning, anti-friction ball and roller bearings shall be in limits of figure 1.

(8) Inspect installed mono-ball bearings for conformance with tightness requirements specified in specific structure repair series manuals A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or

A1-F18AE-SRM-600 thru A1-F18AE-SRM-750. Assemblies correctly installed, but tighter than specified, may be loosened by pressing as shown in figure 2, depot maintenance.

(9) Mono-ball bearings which feel rough or gritty when rotated shall be examined for cause. Bearings containing any of following defects shall be rejected:

(a) Dirty or soiled grease - those bearings may be cleaned and relubricated.

(b) Burrs on mating surface of either race.

(c) Scratches, cuts, or dents on mating surface of either race deeper than is consistent with RHR 63 finish.

(10) Installed teflon lined bearings having any measurable axial or radial movement shall be rejected, unless specified otherwise.

(11) Installed teflon lined mono-bearings having maximum torques more than twice maximum allowable torque for uninstalled bearing or 10 inch pounds more than maximum allowable torque for uninstalled bearing, whichever is smaller, shall be rejected unless otherwise specified.

f. Only the type of MIL-R-46082 retaining compound and the grade of MIL-S-22473 primer specified shall be used.

g. Retaining compound and primer shall be from same manufacturer.

5. Cleaning. All visible contamination or foreign material shall be removed from mating surfaces.

NOTE

Titanium surfaces shall not be primed. If both mating surfaces are titanium, engineering disposition is required.

6. Priming. After cleaning, both mating surfaces shall be primed with specified grade of MIL-S-22473 primer.

a. Primers shall be cured for minimum of 30 minutes at room temperature before application of retaining compounds.

b. Primed surfaces shall be handled with clean cotton work gloves.

c. If retaining compounds are not applied within 4 hours after priming, primed surfaces shall be protected from contamination by wrapping with untreated kraft paper.

d. If retaining compounds are not applied within 7 days of priming or if primed surfaces become contaminated, surfaces shall be recleaned and reprimed.

e. Solvent or primer shall not be allowed to enter pre-lubricated bearings.

7. Application of Retaining Compounds.

Retaining compounds shall be kept in original containers until they are applied.

a. Keep containers tightly closed when not in use.

b. Remove only enough retaining compound from container to do job.

c. Material removed for job and not used shall be disposed.

d. Before application, make sure retaining compound is smooth and free of lumps or caked material, and contains no foreign material.

e. Compounds not meeting above conditions shall be discarded.

f. Enough retaining compound shall be evenly applied to both mating surfaces to make sure of gap fill and 100 percent squeeze out on both ends of part(s).

g. If one mating surface is chilled to aid installation, retaining compound shall be applied only to non-chilled surface.

h. Application of retaining compounds to bearings/bushings and bore surfaces having lubricant passages shall be as shown in figure 3.

8. Installation.

a. Except for spline or press fit assemblies, parts shall be rotated minimum of 180 degrees in relation to one another during assembly to make sure of even distribution of retaining compound.

b. Installation, repositioning, fixturing, and cure times shall be within time limits specified in table 2.

Table 2. Installation, Repositioning, Fixturing, and Cure Times

MIL-R-46082 Retaining Compound	Type I		Type II		Type III	
Primer Grade	T	N	T	N	T	N
Maximum Mating Time After Retaining Compound Application (Minutes)	4	10	4	10	4	10
Maximum Repositioning Time After Installation (Minutes)	1	5	1	5	1	5
Minimum Fixturing Time After Assembly	5 Minutes	10 Minutes	5 Minutes	2 Hours	5 Minutes	2 Hours
Minimum Full Cure Time After Assembly (Hours)	2	12	6	24	6	24

c. If any time limits specified in table 2 are exceeded, parts shall be immediately disassembled. Uncured retaining compound shall be removed by wiping with cleaning cloth moistened with solvent or cleaning compound.

d. Parts must be reinspected, cleaned, and primed, before reinstallation.

e. Excess retaining compound shall be removed after minimum fixturing times.

9. Disassembly of Parts After Curing.

a. Forces and methods for separating parts assembled with retaining compounds are similar to those required for parts assembled using press fit and/or shrink fit methods.

b. Disassembly loads shall be applied in such a manner that parts or structure requiring reuse are not damaged.

c. Elevated or sub-zero temperatures may be used to aid separation provided temperatures used will not damage parts.

d. Parts separated after retaining compound has cured shall be inspected to specifications listed in specific structure repair series manuals A1-F18AC-SRM-210 through A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750 before reuse.

10. PROCEDURES.

Support Equipment Required

None

Materials Required

NOTE

Alternate item part numbers are shown indented.

Specification or Part Number

Nomenclature

DS-108F
5772 048

Solvent, Wipe
Cleaning Compound

Materials Required (Continued)**NOTE**

Alternate item part numbers are shown indented.

**Specification
or Part Number****Nomenclature**

MIL-C-87962, TYPE 1	Cleaning Cloth
MIL-G-3866, TYPE 1, SMALL	Gloves, Men's
MEDIUM	
LARGE	
A-A-203	Paper, Kraft, Untreated
MIL-R-46082,	Retaining Compound,
TYPE 1, 2, or 3	Sealing Compound
MIL-S-22473,	Primer, Sealing
GRADES N and T	
FORM R	
AA1048TY1CL1GRIT 180X9X11	Cloth, Abrasion

11. General.

a. Make sure parts to be assembled meet specified tolerances in specific structure repair series manuals A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750.

b. Parts should be able to be assembled dry using hand pressure unless interference fit is required.

c. Make sure primer grade and retaining compound type are as specified in specific structure repair series manuals A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750.

d. Primer and retaining compound shall be purchased from same manufacturer.

e. Squeeze out small sample of retaining compound onto clean metal surface. Sample must appear smooth and free of lumps and foreign particles. Discard sample.

WARNING

Solvent should be used with care. Gloves must be worn to prevent injury.

Cleaning compound may cause skin irritation. Avoid contact with skin and clothing. Wash thoroughly after handling.

NOTE

If either surface to be bonded is dry film lubricated, depot engineering disposition is required.

12. **Cleaning.** Clean mating surface(s) using cleaning cloth moistened with solvent or cleaning compound. Make sure mating surface(s) is free of contamination or foreign material. Allow to air dry for 15 minutes before application of primer.

NOTE

Titanium surfaces shall not be primed. If both mating surfaces are titanium, engineering disposition is required.

13. Priming.**WARNING**

Primer is highly flammable and toxic. Do not use near open flame or sparks. Use only in well ventilated areas.

a. Apply specified grade of MIL-S-22473 primer to mating surface(s).

(1) Apply primer to pre-lubricated bearings by brush being careful not to allow primer to enter bearing.

(2) All other surfaces, apply primer by brushing, dipping, or spraying.

(3) Allow primer to air dry for minimum of 30 minutes before application of retaining compounds.

b. If parts are not assembled within 4 hours, they shall be wrapped in untreated kraft paper.

c. If primed surfaces are not assembled within seven days, or if they become contaminated after priming, repeat paragraphs 12 and 13.

14. Application of Retaining Compounds.

WARNING

Retaining Compound is flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

a. Squeeze out small amount of specific retaining compound directly onto both mating surfaces.

b. Evenly spread retaining compound using tip of plastic container.

c. Apply enough retaining compound to provide gap fill and 100 percent squeeze out on both ends of mated joint.

d. Apply retaining compound to bearings having lubricant passages on outer surface as shown in figure 1.

e. If one mating surface is chilled to aid assembly, apply retaining compound only to non-chilled surface.

NOTE

Retaining compounds are not self centering. The use of alignment fixtures may be required to get specific location and alignment.

15. Assembly.

a. After retaining compound application mate parts within time specified in table 2.

(1) Except for spline or press fit assemblies, parts shall be rotated a minimum of 180 degrees to make sure of even distribution of retaining compound.

(2) If repositioning/reassembling is required, do within time specified in table 2.

b. If mating and repositioning is not done within specified time limits of table 2, immediately disassemble.

WARNING

Solvent should be used with care. Gloves must be worn to prevent injury.

Cleaning compound may cause skin irritation. Avoid contact with skin and clothing. Wash thoroughly after handling.

c. Remove all non-cured retaining compound from surface(s) using cleaning cloth moistened with solvent or cleaning compound.

d. Remove cured retaining compound using 180 grit abrasive cloth.

e. If cured retaining compound was removed, reinspect parts as specified in specific structure repair series manuals A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750.

f. Reclean, paragraph 12.

g. Reprime, paragraph 13.

h. Reapply retaining compound, paragraph 14.

i. Reassemble, paragraph 15.

j. Parts correctly mated and positioned should not be disturbed for minimum fixturing time, refer to table 2.

k. After minimum fixturing time, remove excess retaining compound from outer surfaces using cleaning cloth moistened with solvent or cleaning compound.

l. Do not load or test assemblies until minimum full cure time of table 2 is elapsed.

16. Disassembly of Mated Parts After Curing.

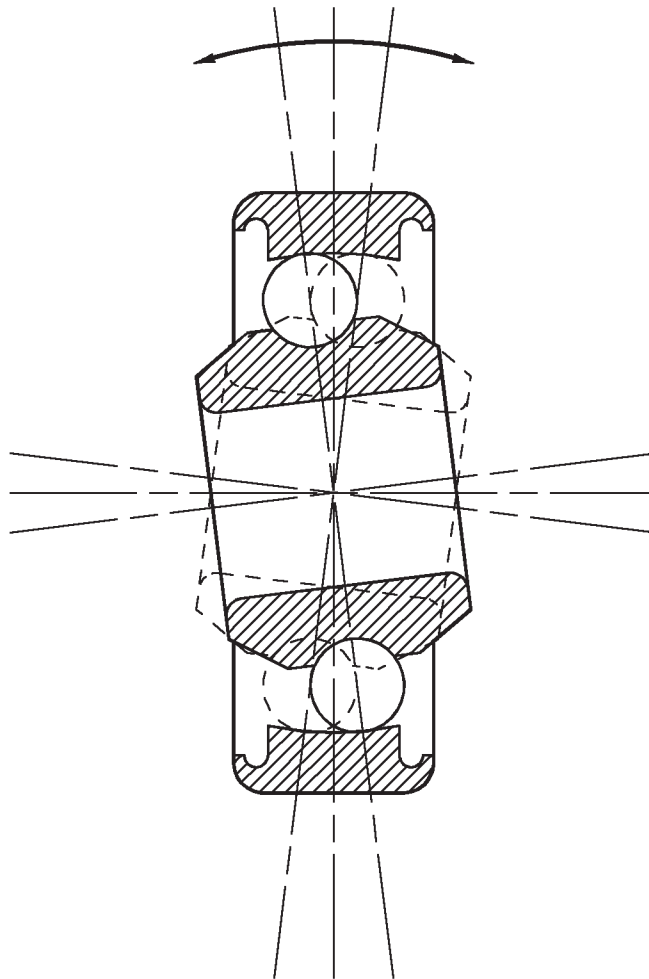
a. At room temperatures, assemblies retained with type 1 and 2 retaining compounds will require shear loads of approximately 3,000 PSI for disassembly. Type 3 retaining compounds require shear loads of approximately 4,000 PSI for disassembly.

b. Any method may be used to apply removal loads so part or structure requiring reuse is not damaged. Procedures shown in figures 4, 5, 6, and 7 may be used for smaller bearings. Larger bearings/bushings same procedure, but larger loads applied by mechanical or hydraulic presses, see figures 4 and 6.

c. Removing bearings/bushings from bores, procedure shown in figures 6 and 7 are based on applying removal loads on outer bearing races only.

d. Bearings installed on a shaft, support inner race of bearing and supply removal loads on end of shaft.

e. Same procedures shown for removal of bearings/bushings may be used for removing mono-ball bearings.



TORQUE VALUES LISTED BELOW APPLY ONLY TO ROTATION
IN DIRECTION SHOWN AND UP TO MAXIMUM MISALIGNMENT
ANGLE SPECIFIED FOR BEARING.

NOMINAL BEARING BORE DIAMETER (INCHES)	MAX. ANGULAR TORQUE (INCH-LBS)
0.190	2
0.250	3
0.312	5
0.375	8
0.4375	10
0.500	14
0.5625	15
0.625	16
0.750	18
0.875	19
1.000	20

18AC-SRM-20-(219-1)23-CAT1

Figure 1. Angular Movement Tightness Acceptance Limits of Self-Aligning, Anti-Friction Ball and Roller Bearings.

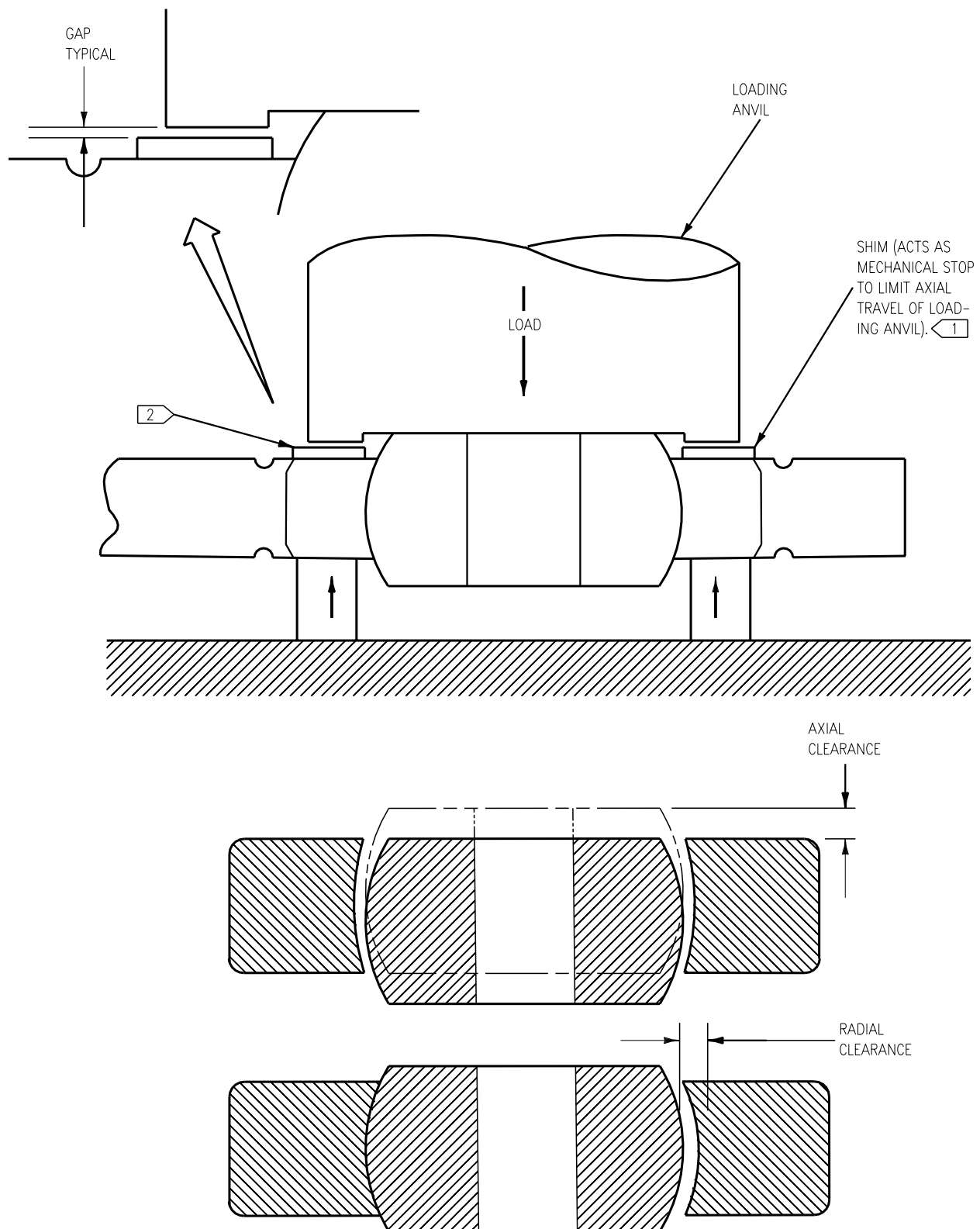





Figure 2. Loading Mono-Ball Bearings to Decrease Tightness, Depot Maintenance (Sheet 1)

NORMAL BORE OF BEARING	AXIAL CLEARANCE INCH (MAXIMUM)	RADIAL CLEARANCE INCH (MAXIMUM)	MAXIMUM RADIAL OR AXIAL TORQUE INCH-POUNDS 
0.190	0.006	0.002	2
0.250	0.007	0.002	3
0.312	0.008	0.002	5
0.375	0.009	0.0025	8
0.4375	0.010	0.0025	10
0.500	0.011	0.0025	14
0.5625	0.011	0.0025	15
0.625	0.012	0.003	16
0.750	0.014	0.003	18
0.875	0.015	0.003	19
1.000	0.016	0.003	20

LEGEND

 USE SHIMS UNDER MECHANICAL STOPS, AS REQUIRED, TO ALLOW FOR BEARING MANUFACTURING TOLERANCES.

 SHIM THICKNESS SHALL BE SELECTED SO BALL CAN BE MOVED IN STEPS OF 0.004 TO GET REQUIRED LOOSENESS. GAP SHOULD START AT 0.004.

 TORQUE LIMITS APPLY TO LUBRICATED BEARINGS IN ANY DIRECTION OF TORQUE LOADING TO MAXIMUM BALL AXIS MISALIGNMENT OF 5 DEGREES. SPECIFIED LIMITATIONS TAKE PRECEDENCE OVER THESE TORQUE LIMITS.

TORQUE LIMITS DO NOT APPLY TO POLYTETRAFLUORETHYLENE (TEFLON) LINED BEARINGS. THIS TYPE BEARING HAS FOLLOWING TIGHTNESS ACCEPTANCE CRITERIA:

AXIAL CLEARANCE-0.000 (ALL DIAMETERS).

RADIAL CLEARANCE-0.000 (ALL DIAMETERS).

MAXIMUM TORQUE- NO LIMITS ESTABLISHED, HOWEVER MAXIMUM TORQUE USUALLY EXCEEDS VALUES FOR LUBRICATED BEARINGS.

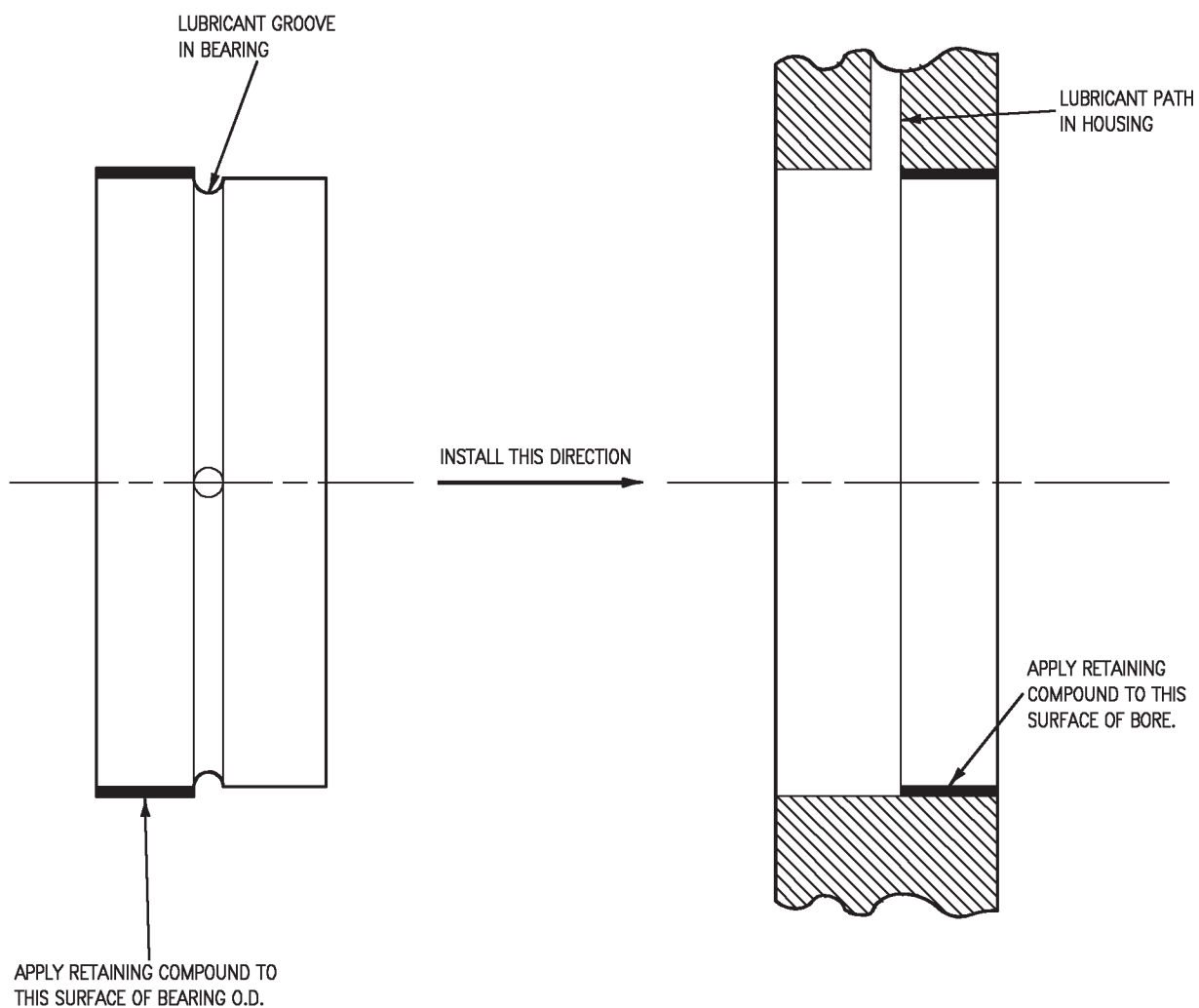
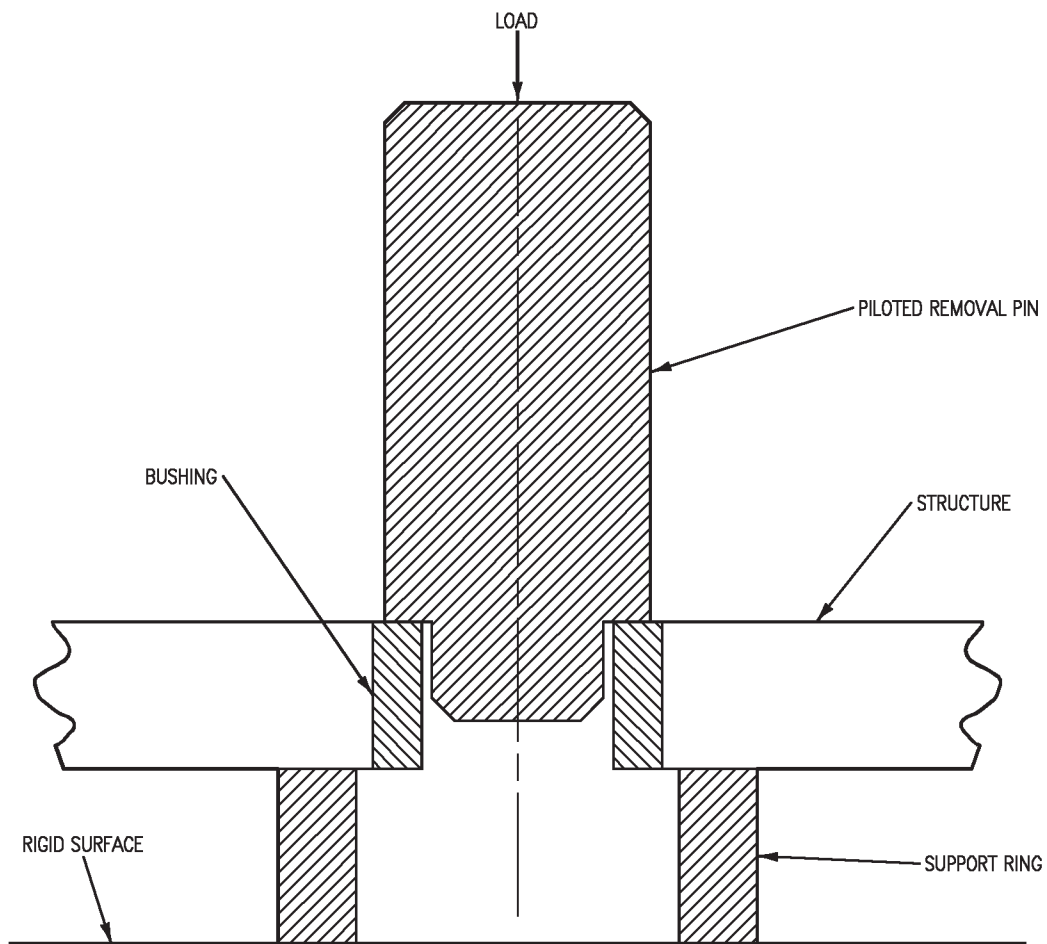


Figure 3. Application of Retaining Compound to Bearings and Bores Having Lubricant Passages



REMOVAL LOADS MAY BE APPLIED BY IMPACT
OR BY MECHANICAL/HYDRAULIC PRESS.

Figure 4. Bushing Removal - Impact/Press Procedure

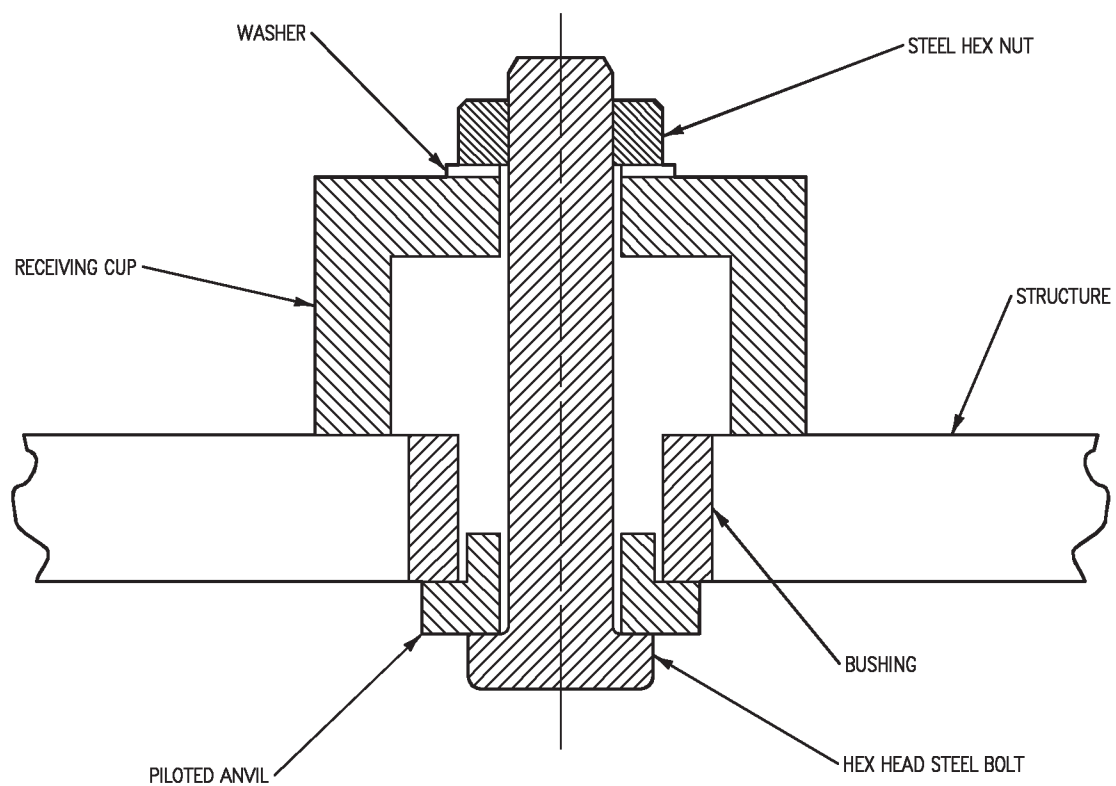
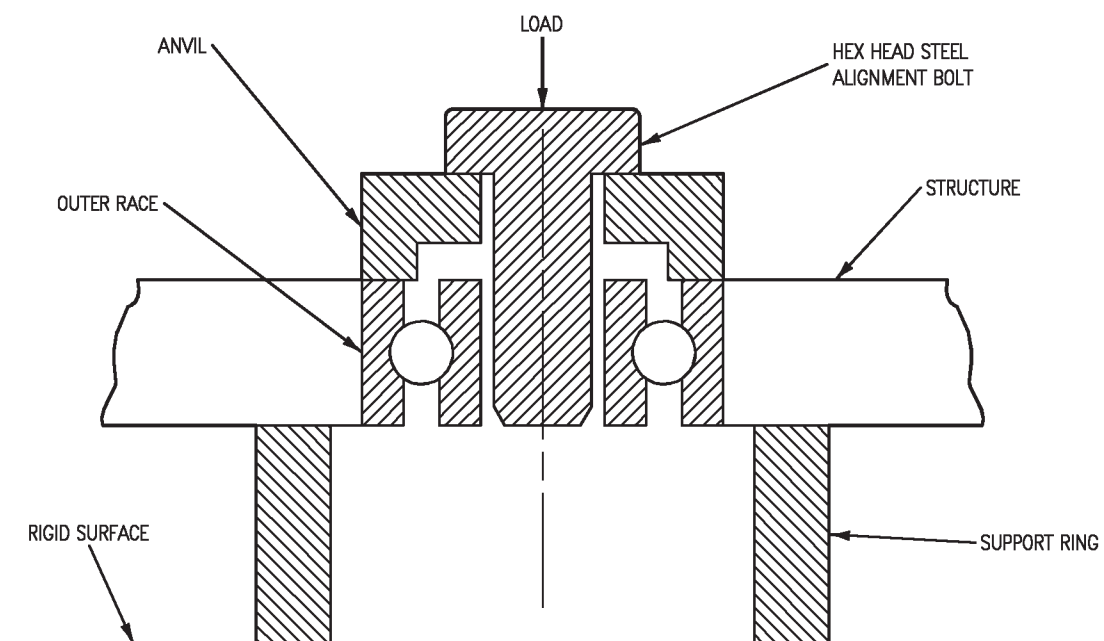


Figure 5. Bushing Removal - Bolt/Nut Procedure



REMOVAL LOADS MAY BE APPLIED BY IMPACT
OR BY MECHANICAL/HYDRAULIC PRESS.

Figure 6. Bearing Removal - Impact Press Procedure

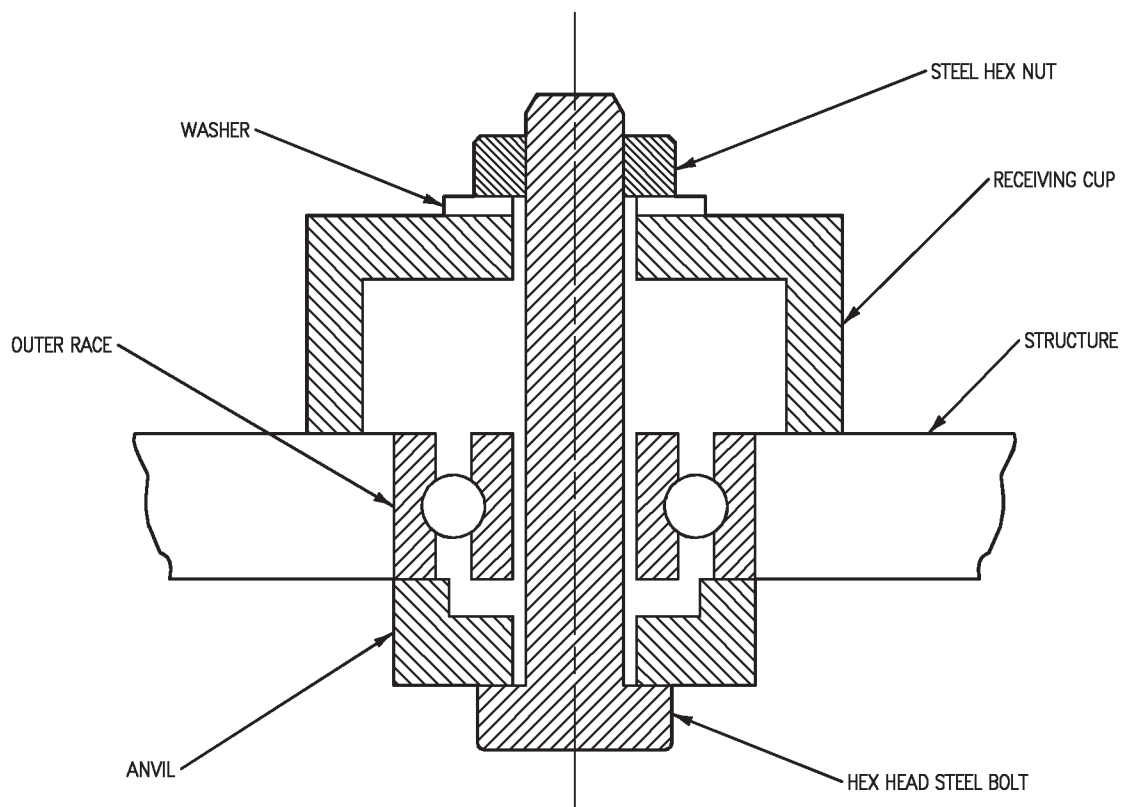


Figure 7. Bearing Removal - Bolt/Nut Procedure

ORGANIZATIONAL, INTERMEDIATE, AND DEPOT MAINTENANCE

STRUCTURE REPAIR

SHOP PRACTICES

WORKING ALUMINUM ALLOYS

Reference Material

Structure Repair, General Information	A1-F18AC-SRM-200
Flat Pattern Development.....	WP004 00
Forming Sheet Metal.....	WP004 01
Locating Blind Holes and Trim Lines.....	WP004 03
Fasteners	WP004 06
Cold Working Fastener Holes.....	WP004 10
Heat Treatment of Aluminum Alloys.....	WP004 11
Countersink Fillers	WP004 12
Fastener Hole Classification Data.....	WP004 15
Aircraft Corrosion Control.....	A1-F18AC-SRM-500
Cleaning.....	WP006 00

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Free-hand Drilling.....	2
Heat Treatment of Aluminum Alloys	2
Locating Blind Holes and Trim Lines	1

Record of Applicable Technical Directives

None

1. INTRODUCTION.

2. Aluminum alloy is relatively lightweight, corrosion resistant, structural metal. Aluminum is easily worked and is currently used more for aircraft skins and structure than any other material.

3. FLAT PATTERN DEVELOPMENT. (WP004 00).

4. FORMING SHEET METAL. (WP004 01).

5. LOCATING BLIND HOLES AND TRIM LINES. (WP004 03).

6. COLD WORKING FASTENER HOLES. (WP004 10).

7. **HEAT TREATMENT OF ALUMINUM ALLOYS.**
(WP004 11).

8. **COUNTERSINK FILLERS.** (WP004 12).

9. **FASTENER HOLE CLASSIFICATION DATA.**
(WP004 15).

10. **FREE-HAND DRILLING.** Free-hand drilling is organizational maintenance.

Support Equipment Required

NOTE

Alternate item type designation or part numbers are listed in parentheses.

Part Number or Type Designation	Nomenclature
NAS 907 Types A, (B, or C)	High Speed Steel Drills, M1 and M2
GGG-R-180D (—)	Carbide Reamer, 8 % Cobalt
GGG-C-163D (—)	Carbide Countersinks, 8 % Cobalt
—	Step Drill
—	Drill Stop
K652-2989-GT	Vixen File Block
—	Pneumatic Drill Motor, as Req'd

Materials Required

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
ISOPAR M	Cutting Fluid
MMS611	Lubricant
IMMUNOL #1809	Lubricant
BIO-COOL 500NF	Lubricant
—	Cetyl Alcohol, Stick Form
A-A-1047 GRIT, 80 or Finer	Abrasive Paper, Silicone Carbide
AA1048TY1CL1GR	Aluminum Oxide
IT809X11 —	Abrasive Paper

Materials Required (Continued)

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
—	Synthetic or Paper Nonwoven Wipers

a. Apply enough force to keep drill cutting continuously.

b. Excessive force may bow or bend drill causing elongated holes and tool breakage.

c. Use shortest drill with shortest flutes possible.

d. Undersize pilot holes; #40 or 0.125 inch dia. may be used to reduce force required for feeding.

e. When reaming, countersinking, and counterboring, force required to maintain constant feed rate normally will be less than required for drilling.

f. When drill or reamer exits on back side of structure being worked, slowly rotate drill motor clockwise while pulling tool back through hole. Do not stop or reverse rotation when removing tool from hole.

11. Requirements.

a. Drill motors shall not be triggered and air hoses shall not be 'C'-Clamped to reduce drilling speeds below maximum allowed. Always use drill motors with rated speeds below specified maximum limits.

b. Temperatures at periphery of hole(s) during drilling shall be kept to minimum so not to cause annealing of metal around hole.

c. To get best possible hole tolerance, hole finish, and to prevent tool breakage, always support thin gage material on exit side of hole, if possible.

d. Drilling and reaming holes through combination of dissimilar alloys, use feed and speed requirements of harder material. Drilling or reaming direction shall be from side of harder material.

e. Frequent drill and reamer withdrawal and use of lubricants may be required when working from side of softer material.

f. When using step drills, first step must drill completely through material before final step of drill begins cutting.

g. Paper and synthetic nonwoven wipers shall not be used for final cleaning of painted, bare, anodized surfaces, or exterior surfaces of aircraft.

h. When drilling into parts near electrical wires or equipment, fluid lines, control cables, or inner structure, drill stops shall be used. Drill stop should be adjusted to limit drill point to 1/16-inch penetration beyond sheet or part.

12. Hole Quality.

a. Visual Inspection:

(1) Burrs around holes shall be removed.

(2) Hole finish should be RHR 125 or better.

(3) No tool marks or scratches allowed 45 degrees or less with hole axis.

(4) Make sure tool marks or scratches do not cause surface finish of hole(s) or countersink(s) to exceed specified limits for specific fastener installation.

NOTE

Surfaces with tool marks or scratches may be reworked to pass visual and dimensional inspection.

(5) Tool marks shall not exceed 0.001 inch deep.

b. Dimensional Inspection:

(1) Make sure hole location and edge distance are correct.

(2) All holes shall be drilled normal to surface, as required.

(3) All holes shall be drilled within minimum or maximum specifications.

(4) All countersinks shall have correct diameter, included angles, alignment, or intersection radii; allowing correct seating of fastener head within flushness and gap ranges specified in specific procedure work package.

c. Inspection Frequencies and criteria:

(1) Inspect all hole(s) when cold worked, during interference fastener removal/installation, or when specifications require 100 percent inspection.

(2) When hole(s) require tolerance of 0.003 inch or less, inspect 100 percent.

(3) If hole pattern is four or less holes inspect 100 percent.

(4) If hole pattern is 4 to 30 holes, inspect 3 randomly selected holes in pattern.

(5) If hole pattern is over 30 holes inspect 10 percent of holes randomly selected.

(6) If any hole is rejected, inspect all remaining holes in pattern.

(7) Holes having total diametrical tolerance greater than 0.003 inch, inspection to reasonably make sure visual and dimensional acceptance criteria specified are being met and maintained.

d. Hole shall be normal to surface upon which fastener head will seat.

e. For head gap, tilt, and other specific criteria (WP004 06).

f. Cylindrical holes and countersinks shall not be out of round or tapered to extent high and low limits of hole tolerance is exceeded.

g. Concentricity of hole, countersink, and radius shall meet specifications of fastener(s) to be installed.

h. Hole finish shall meet requirements of specific procedure work package.

13. Hole Cutting Tools.

a. Aluminum alloys shall be drilled using standard high speed steel H.S.S. tools.

b. Cutting tools that are bent, damaged, dull, or incorrectly sharpened shall not be used.

c. Tools having smeared metal bonded or welded to margins shall not be used for making finish holes.

d. Countersink, counterbore, spotface, and reamer pilot diameters shall be 0.001 to 0.004 inch smaller than diameter of hole to prevent tool chatter marks and out of tolerance conditions.

e. Deburring tools or Vixen Blocks must meet following requirements:

(1) Attach screws must be recessed.

(2) Edge distance must be adequate to prevent contact with skin surface.

(3) Teeth must not be allowed to be clogged.

f. Drilling speeds shall not exceed table 1 requirements.

Table 1. Maximum Speeds for Free-hand Assembly Drilling

Material to be Drilled	Type Drill T.F.I.M.	Maximum							
		#40	1/8	3/16	1/4	5/16	3/8	7/16	1/2
Aluminum Alloys	Type U-Z	6000	6000	6000	2500	2000	1500	1250	1000
NOTE: 1. Free-hand assembly drilling/reaming of holes larger than 1/4-inch in aluminum is not recommended without drilling aids.									

14. Lubricants.

a. Approved lubricant shall be used, as required, see table 2.

Table 2. Lubrication Chart for Aluminum Alloys

Lubrication Type	Application Method
Dry	None
ISOPAR M	Mist
MMS611	Mist or Flood
IMMUNOL	Mist or Flood
BIO-COOL	Mist or Flood
CETYL ALCOHOL	Stick

b. Mix ratios are, water/lubricant, as below;

- Bio-cool and 500NF 20 to 1.
- MMS611 and Immunol #1809 30 to 1.

c. Mixing lubricants or use of deteriorated or contaminated lubricants is prohibited.

d. Spray mist applied Isopar M, containing 1 percent Butyl Cellosolve, may be used for all assembly drilling of bare and primed parts and assemblies, assemblies having faying surface sealed areas, and assemblies which cannot be separated for

cleaning. When Isopar M is correctly spray mist applied, cleaning of parts and assemblies is not required by other applicable cleaning requirements for sealing, bonding, or painting.

e. Cetyl alcohol, in stick form, applied to tool before use, may be used as lubricant in areas where other lubricants are not practical. Disassembly and cleaning of parts is not required after use of cetyl alcohol if applied per this step.

f. When water based coolants, applied either by flood or mist are used for assembly drilling, assemblies shall be disassembled and solvent cleaned per (A1-F18AC-SRM-500, WP006 00) to remove all traces of lubricant.

g. Bonded structures and assemblies that can not be separated for cleaning, water based coolants can be used only by dipping cutting tool into coolant and allowing excess coolant to drip off before use.

15. Tool Feed and Speed.

a. Drill shall not be allowed to dwell on material without cutting. Force shall be applied to drill immediately on contact with material being drilled.

b. Drill speeds in relation to hole size and material, shall be per table 1.

c. Speed for reaming, countersinking, and counterboring shall be 1/3 to 1/2 of maximum drilling speeds specified in table 1 for drilling.

16. Hole Alignment, Gaps, and Preload. All parts shall be securely fastened together before drilling/reaming through more than one thickness. There are no exceptions allowed on joints that can not be disassembled for cleaning and deburring.

17. Deburring. Deburring is organizational maintenance.

a. Holes shall be free of dirt or contaminates that may be imbedded into surface during deburring (A1-F18AC-SRM-500, WP006 00).

b. Use only clean abrasive cloths or abrasive papers.

c. Use 80 grit or finer abrasive cloth/paper for normal deburring or Vixen Block(s).

d. Fastener holes may be deburred with H.S.S. or carbide rotary deburring tools; however, speeds shall not exceed 250 S.F.M.

e. Deburr hole(s) using Vixen Block as follows;

(1) Use light pressure with limited stroke. Excess pressure will cause tool to dig or grab, possibly cause burr to jam in tool and scratch periphery of hole. Stroke should be lower than required to cover area to be deburred.

(2) Use forward direction only. Do not use forward/aft, scrubbing, procedure. Forward and aft procedure may trap chips and become cutting agent.

(3) Clean chips from tool after each stroke. Cleaning prevents trapping chips in tool and causing scratches/gouges in material.

(4) Do not use defective tool. Defective tools pick up chips and cause scratching.

ORGANIZATIONAL, INTERMEDIATE, AND DEPOT MAINTENANCE

STRUCTURE REPAIR

SHOP PRACTICES

EMI ELECTRICAL BONDING STRIP CONTACT VERIFICATION

Reference Material

None

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Record of Applicable Technical Directives

None

1. PROCEDURE.

2. EMI electrical contact verification is done after installation of new repaired bonding strip or during routine maintenance.

b. Brush small amount of paint on each springfinger contact point.

c. Immediately close cover/door so springfingers contact mating structure.

d. Open cover/door. Each springfinger contacting mating structure will leave paint mark on mating structure.

Support Equipment Required

None



Materials Required

Specification or Part Number	Nomenclature
—	Tempera Color, Water Soluble Paint
H-B-643, TYPE 2, CLASS 1, SIZE 1	Acid Swab Brush
CCC-C-440 TYPE 1 CLASS 1	Cheesecloth

a. Mix water soluble paint per instructions on container. If required, thin paint with water.

Only slight pressure is required to bend springfingers. Springfingers break easily.

e. Carefully bend toward mating structure each springfinger failing to make contact.

f. Repeat steps b, c and d for each springfinger failing to make contact.

g. After springfingers meet requirements of paragraph 3, remove water soluble paint from springfingers with water dampened cheesecloth.

3. **REQUIREMENTS.** EMI electrical bonding strip springfinger contact point shall not exceed the below:

a. Strip, three inches or larger at depot maintenance:

(1) If all springfingers in 0.50 inch length do not contact mating surface, repair is required.

(2) If fifty percent of springfingers in 1.50 inch length do not contact mating surface, repair is required.

b. Strip, three inches or larger at organizational or intermediate maintenance:

(1) If all springfingers in 1.00 inch length do not contact mating surface, repair is required.

(2) If fifty percent of springfingers in 3.00 inch length do not contact mating surface, repair is required.

c. Strip, less than three inches at depot maintenance: if twenty-five percent of springfingers do not contact mating surface, on any individual length, repair is required.

d. Strip, less than three inches at organizational or intermediate maintenance; if fifty percent of springfingers do not contact mating surface, on any individual length, repair is required.

e. Springfinger contact point: Centerline springfinger contact point minimum of 0.031 inch from edge of mating structure, see figure 1.

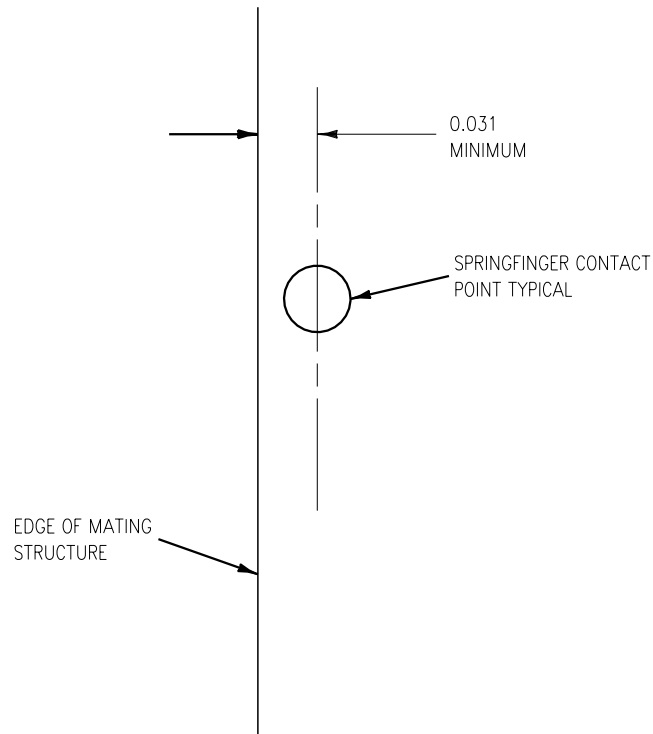


Figure 1. EMI Electrical Bonding Strip Contact Verification

DEPOT MAINTENANCE

STRUCTURE REPAIR

SHOP PRACTICES

CLOSE TOLERANCE HOLE FABRICATION, REPAIR NUMBERS 10 THRU 20

Reference Material

Structure Repair, General Information	A1-F18AC-SRM-200
Fastener Hole Classification Data	WP004 15

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Record of Applicable Technical Directives

None

1. CLOSE TOLERANCE HOLE FABRICATION.

2. This work package provides guidelines to depot personnel for correct selection of tools and equipment required for close tolerance hole fabrication. To make sure hole integrity is maintained, use of repair numbers is required. For fastener hole classification data (WP004 15).

3. **REPAIR 10.** See figure 1. Repair 10 is for:

a. Class 1 holes in graphite epoxy skin.

b. Class 1 holes in graphite epoxy skin and class 1 holes in graphite epoxy substructure.

c. Class 1 holes in graphite epoxy skin and class 1 holes in aluminum substructure 0.150 inch thick or less.

4. **REPAIR 11.** See figure 2. Repair 11 is for:

a. Class 2 holes in graphite epoxy skin.

b. Class 2 holes in graphite epoxy skin and class 2 holes in graphite epoxy substructure.

c. Class 2 holes in graphite epoxy skin and class 2 holes in aluminum substructure 0.150 inch thick or less.

5. **REPAIR 11A.** See figure 3. Repair 11A is for:

a. Class 2 holes in graphite epoxy skin.

b. Class 2 holes in graphite epoxy skin and class 2 holes in graphite epoxy substructure.

c. Class 2 holes in graphite epoxy skin and class 2 holes in aluminum substructure 0.150 inch thick or less.

6. **REPAIR 12.** See figure 4. Repair 12 is for:

a. Class 2G holes in graphite epoxy skin.

b. Class 2G holes in graphite epoxy skin and class 2G holes in graphite epoxy substructure.

c. Class 2G holes in graphite epoxy skin and class 2G holes in aluminum substructure 0.150 inch thick or less.

7. **REPAIR 12A.** See figure 5. Repair 12A is for:

a. Class 2G holes in graphite epoxy skin.

b. Class 2G holes in graphite epoxy skin and class 2G holes in graphite epoxy substructure.

c. Class 2G holes in graphite epoxy skin and class 2G holes in aluminum substructure 0.150 inch thick or less.

8. **REPAIR 13.** See figure 6. Repair 13 is for:

a. Class 3 holes in graphite epoxy skin.

b. Class 3 holes in graphite epoxy skin and class 3 holes in graphite epoxy substructure.

c. Class 3 holes in graphite epoxy skin and class 3 holes in aluminum substructure 0.150 inch thick or less.

9. **REPAIR 14.** See figure 7. Repair 14 is for:

a. Class D holes in graphite epoxy skin.

b. Class D holes in graphite epoxy skin and class D holes in graphite epoxy substructure.

c. Class D holes in graphite epoxy skin and class D holes in aluminum substructure 0.150 inch thick or less.

10. **REPAIR 15.** See figure 8. Repair 15 is for:

a. Jo-Bolt holes in graphite epoxy skin.

b. Jo-Bolt holes in graphite epoxy skin and Jo-Bolt holes in graphite epoxy substructure.

c. Jo-Bolt holes in graphite epoxy skin and Jo-Bolt holes in aluminum substructure 0.150 inch thick or less.

11. **REPAIR 16.** See figure 9. Repair 16 is for:

a. Olympic-Lok holes in graphite epoxy skin.

b. Olympic-Lok holes in graphite epoxy skin and Olympic-Lok holes in graphite epoxy substructure.

c. Olympic-Lok holes in graphite epoxy skin and Olympic-Lok holes in aluminum substructure 0.150 inch thick or less.

12. **REPAIR 17.** See figure 10. Repair 17 is for Class 1 holes in graphite epoxy skin.

13. **REPAIR 18.** Data to be supplied when available.

14. **REPAIR 19.** Data to be supplied when available.

15. **REPAIR 20.** Data to be supplied when available.

REPAIR 10

HOLE COLOR CODE	ORANGE	GREEN	PINK	VIOLET
HOLE SIZE	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.
POTTING				
BUSHING LINER RE374000002-1	-179	-103	-103	-101
STEP PIN RE374000002-1	-182 -204 -205	-105 -106 -107	-108 -109 -110	-112 -181 -114
DRILLING				
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110314-1001 1100-450 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	1	-231
COOLANT BUSHING RE574000002-1	-410	-413	-416	-C
DRILL TFIM25.0253	-723	-721	-705	-461
REAMING PRE-CLASS 1 HOLE				
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110314-1001 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	1	-232
COOLANT BUSHING RE574000002-1	1 -421 -422	1 -424 -425	1 -427 -428	-DL -DM -DN
REAMER TFIM25.121	1 -1986 -2142	1 -2611 -2767	1 -3236 -3392	-3705 -3861 -4017
REAMING FINAL HOLE				
DRILLING MACHINE	500 RPM PISTOL GRIP	500 RPM PISTOL GRIP	500 RPM PISTOL GRIP	250 RPM PISTOL GRIP
REAMER TFIM25.126	-1897 -2028 -2184	-2497 -2653 -2809	-3122 -3278 -3434	-3747 -3903 -4059

Figure 1. Close Tolerance Hole Fabrication, Repair 10 (Sheet 1)

REPAIR 10 (CONTINUED)

HOLE COLOR CODE	ORANGE	GREEN	PINK	VIOLET
HOLE SIZE	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.
COUNTERSINKING SKIN				
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP
NOSE ADAPTER RE574000002-1	1	1	1	1
COOLANT BUSHING RE574000002-1	1	1	1	1
MICROSTOP CAGE RE574000002-1	STANDARD	STANDARD	STANDARD	STANDARD
COUNTERSINK BODY TFIM25.0120	-187 -200 -215	-247 -262 -278	-309 -324 -340	-372 -387 -403
CARBIDE INSERT TFIM25.0121	-492	-492	-493	-493

LEGEND

1 NOT REQUIRED

REPAIR 11

HOLE COLOR CODE	SILVER	ORANGE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	5/32 FIRST OVS. SECOND OVS.	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING						
BUSHING LINER RE374000002-1	1	-179	-103	-103	-101	-102
STEP PIN RE374000002-1	1	-182 -204 -205	-209 -210 -211	-212 -213 -214	-112 -113 -114	-116 -117 -118
DRILLING						
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110314-1001 1100-450 RPM POSITIVE FEED	74D110314-1001 1100-450 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	1	1	-231	-231
COOLANT BUSHING RE574000002-1	1	-398	-101	-104	-C	-L
DRILL TFIM25.0253	-243	-279	-352	-416	-461	-505
REAMING SKIN AND SUBSTRUCTURE						
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-2	1	1 -554 -389	1	1	-232	-232
COOLANT BUSHING RE574000002-1	1	1	1 -102 -103	1 -105 -106	-E -G -J	-N -R -T
REAMER TFIM25.0253	1	1 -2034 -2190	1 -2659 -2815	1 -3284 -3440	-3760 -3909 -4065	-4373 -4534 -4690
FREE HAND COUNTERSINKING						
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP
MICROSTOP CAGE	STANDARD	STANDARD	STANDARD	STANDARD	STANDARD	STANDARD

Figure 2. Close Tolerance Hole Fabrication, Repair 11 (Sheet 1)

REPAIR 11 (CONTINUED)

HOLE COLOR CODE	SILVER	ORANGE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	5/32 FIRST OVS. SECOND OVS.	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
COUNTERSINKING SKIN						
COUNTERSINK BODY TFIM25.0120	-161 1 1	-187 -200 -215	-247 -262 -278	-309 -324 -340	-372 -387 -403	-434 -450 -465
CARBIDE INSERT TFIM25.0121	-492	-492	-492	-493	-493	-497

LEGEND

1 NOT REQUIRED

REPAIR 11A










HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING				
BUSHING LINER RE374000002-1	-198	-199	-200	-201
STEP PIN RE374000002-1	-105 -106 -107	-108 -109 -110	-112 -113 -114	-116 -117 -118
ADAPTER  BUSHING RE574000002-1	-158	-158	-159	-160
DRILLING				
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110314-1001 1100-450 RPM HYDRO CHECK FEED	74D110314-1001 1100-450 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1			-314	-314
COOLANT BUSHING RE574000002-1	-101	-104	-BR	-BL
DRILL TFIM25.0253	-352	-416	-461	-505
REAMING SKIN AND SUBSTRUCTURE				
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1			-313	-313
COOLANT BUSHING RE574000002-1	 -102 -103	 -105 -106	-BS -BJ -BK	-EF -BN -BP
REAMER TFIM25.121	 -2659 -2815	 -3284 -3440	-3760 -3909 -4065	-4373 -4534 -4690

Figure 3. Close Tolerance Hole Fabrication, Repair 11A (Sheet 1)

REPAIR 11A (CONTINUED)

HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
COUNTERSINKING THROUGH DRILL PLATE 3				
DRILLING MACHINE	74D110312-1001 1000 RPM RACK FEED	74D110312-1001 1000 RPM RACK FEED	74D110312-1001 1000 RPM RACK FEED	74D110312-1001 1000 RPM RACK FEED
COUNTERSINK SUBASSEMBLY RE574000002-1	-BG	-BH	-B	-A
COUNTERSINKING SKIN				
COUNTERSINK BODY TFIM25.0120	-247 -262 -278	-309 -324 -340	-372 -387 -403	-434 -450 -465
CARBIDE INSERT TFIM25.0121	-492	-493	-493	-497

LEGEND

- 1 NOT REQUIRED
- 2 ADAPTER BUSHING USED FOR POTTING BUSHING LINERS ONLY, NOT USED WITH DRILLING MACHINES
- 3 SEE TABLE 1

TABLE 1. HOLES REQUIRING COUNTERSINKING THROUGH DRILL PLATE

SKIN PIN	HOLE NUMBERS
74A110600	235-250, 927-931, 933-978, AND 1001-1004
74A110601	174-189, 861-864, 951-1001, AND 1438-1441
74A150600	1-81 AND 195-204
74A150601	1-47, 58-76, 159-180, 383, 384, 437 AND 438

REPAIR 12

HOLE COLOR CODE	ORANGE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING					
BUSHING LINER RE374000002-1	1	-103	-103	-101	-102
STEP PIN RE374000002-1	1	-104 PILOT -105 -106 -107	-104 PILOT -108 -109 -110	-111 PILOT -112 -113 -114	-115 PILOT -116 -117 -118
DRILLING					
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110314-1001 1100-450 RPM POSITIVE FEED	74D110314-1001 1100-450 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	1	-231	-231
COOLANT BUSHING RE574000002-1	1	-101	-104	-C	-L
DRILL TFIM25.0253	-279	-352	-416	-461	-505
REAMING SKIN AND SUBSTRUCTURE					
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-2	1	1	1	-232	-232
COOLANT BUSHING RE574000002-1	1	1 -102 -103	1 -105 -106	-E -G -J	-N -R -T
REAMER TFIM25.0253	1 -2034 -2190	1 -2659 -2815	1 -3284 -3440	-3760 -3909 -4065	-4385 -4534 -4690
FREE HAND COUNTERSINKING					
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP
MICROSTOP CAGE	STANDARD	STANDARD	STANDARD	STANDARD	STANDARD

Figure 4. Close Tolerance Hole Fabrication, Repair 12 (Sheet 1)

REPAIR 12 (CONTINUED)

HOLE COLOR CODE	ORANGE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
COUNTERSINKING SKIN					
COUNTERSINK BODY TFIM25.0120	-187 -200 -215	-247 -262 -278	-309 -324 -340	-372 -387 -403	-434 -450 -465
CARBIDE INSERT TFIM25.0121	-492	-492	-493	-493	-497

LEGEND

 NOT REQUIRED




Figure 4. Close Tolerance Hole Fabrication, Repair 12 (Sheet 2)

REPAIR 12A

HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING				
BUSHING LINER	-198	-199	-200	-201
STEP PIN RE374000002-1	-104 PILOT -105 -106 -107	-104 PILOT -108 -109 -110	-111 PILOT -112 -113 -114	-115 PILOT -116 -117 -118
ADAPTER BUSHING RE574000002-1	-158	-158	-159	-160
DRILLING				
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 1100-450 RPM HYDRO CHECK FEED	74D110314-1001 1100-450 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	-314	-231
COOLANT BUSHING RE574000002-1	-101	-104	-BR	-BL
DRILL TFIM25.0253	-352	-416	-461	-505
REAMING SKIN AND SUBSTRUCTURE				
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	-313	-232
COOLANT BUSHING RE574000002-1	1 -102 -103	1 -105 -106	-BS -BJ -BK	-BM -BN -BP

Figure 5. Close Tolerance Hole Fabrication, Repair 12A (Sheet 1)

REPAIR 12A (CONTINUED)

HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
REAMER TFIM25.121	 -2659 -2185	 -3284 -3440	-3760 -3909 -4065	-4385 -4534 -4690
COUNTERSINKING THROUGH DRILL PLATE 				
DRILLING MACHINE	74D110312-1001 1000 RPM RACK FEED	74D110312-1001 1000 RPM RACK FEED	74D110312-1001 1000 RPM RACK FEED	74D110312-1001 1000 RPM RACK FEED
COUNTERSINK SUBASSEMBLY RE574000002-1	-BG	-BH	-B	-A

LEGEND




-  NOT REQUIRED
-  ADAPTER BUSHING USED FOR POTTING BUSHING LINERS ONLY, NOT USED WITH DRILLING MACHINES
-  SEE TABLE 1

TABLE 1. HOLES REQUIRING COUNTERSINKING THROUGH DRILL PLATE

SKIN P/N	HOLE NUMBERS
74A110600	235-250, 927-931, 933-978, AND 1001-1004
74A110601	174-189, 861-864, 951-1001, AND 1438-1441
74A150600	1-81 AND 195-204
74A150601	1-47, 58-76, 159-180, 383, 384, 437 AND 438

REPAIR 13

HOLE COLOR CODE	ORANGE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING					
BUSHING LINER RE374000002-1	1	-103	-103	-101	-102
STEP PIN RE374000002-1	1	-104 PILOT -184 -106 -107	-104 PILOT -185 -109 -110	-111 PILOT -186 -113 -114	-115 PILOT -116 1 1
DRILLING					
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110314-1001 1100-450 RPM POSITIVE FEED	74D110314-1001 1100-450 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	1	-231	-231
COOLANT BUSHING RE574000002-1	1	-229	-230	-AY	-L
DRILL TFIM25.0253	-279	-353	-417	-734	-505
REAMING SKIN AND SUBSTRUCTURE					
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	1	-232	-232
COOLANT BUSHING RE574000002-1	1	1 -102 -103	1 -105 -106	1 -G -J	-N 1 1
REAMER TFIM25.121	1 -2083 -2239	1 -2659 -2815	1 -3284 -3440	1 -3909 -4065	-4385 1 1
COUNTERSINKING SKIN					
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP
MICROSTOP CAGE	STANDARD	STANDARD	STANDARD	STANDARD	STANDARD
COUNTERSINK BODY TFIM25.0120	-187 -200 -215	-247 -262 -278	-309 -324 -340	-372 -387 -403	-434 1 1
CARBIDE INSERT TFIM25.0121	-492	-492	-493	-493	-497

LEGEND

1 NOT REQUIRED

Figure 6. Close Tolerance Hole Fabrication, Repair 13

REPAIR 14

HOLE COLOR CODE	ORANGE	GREEN	PINK
HOLE SIZE	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.
POTTING			
BUSHING LINER RE374000002-1	1	-103	-103
STEP PIN RE374000002-1	1	1	1
DRILLING			
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED
NOSE ADAPTER RE574000002-1	1	1	1
COOLANT BUSHING RE574000002-1	1	1	1
DRILL TFIM25.0253	-285	-355	-425
REAMING SKIN AND SUBSTRUCTURE			
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED
NOSE ADAPTER RE574000002-1	1	1	1
COOLANT BUSHING RE574000002-1	1	1	1
REMER TFIM25.121	1 -2083 -2239	1 -2708 -2864	1 -3378 -3534
COUNTERSINKING SKIN			
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP
MICROSTOP CAGE	STANDARD	STANDARD	STANDARD
COUNTERSINK BODY TFIM25.0120	-192 -205 -221	-252 -268 -283	-319 -335 -350
CARBIDE INSERT TFIM25.0121	-492	-492	-493

LEGEND

1 NOT REQUIRED

Figure 7. Close Tolerance Hole Fabrication, Repair 14

REPAIR 15

HOLE COLOR CODE	SILVER	ORANGE	GREEN
HOLE SIZE	5/32 FIRST OVS. SECOND OVS.	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.
POTTING			
BUSHING LINER RE374000002-1	1	1	1
STEP PIN RE374000002-1	1	1	1
DRILLING			
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED
NOSE ADAPTER RE574000002-1	1	1	1
COOLANT BUSHING RE574000002-1	1	1	1
DRILL TFIM25.0253	-243	-289	-725
REAMING SKIN AND SUBSTRUCTURE			
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED
NOSE ADAPTER RE574000002-1	1	1	1
COOLANT BUSHING RE574000002-1	1	1	1
REAMER TFIM25.121	1 -1808 1	1 -2158 1	1 -2767 1
COUNTERSINKING SKIN			
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP
MICROSTOP CAGE	STANDARD	STANDARD	STANDARD
COUNTERSINK BODY TFIM25.0120	-161 -177 1	-196 -212 1	-257 -273 1
CARBIDE INSERT TFIM25.0121	-492	-492	-492

LEGEND

1 NOT REQUIRED

Figure 8. Close Tolerance Hole Fabrication, Repair 15

REPAIR 16

HOLE COLOR CODE	BLUE	SILVER
HOLE SIZE	1/8 FIRST OVS. SECOND OVS.	5/32 FIRST OVS. SECOND OVS.
POTTING		
BUSHING LINER RE374000002-1	1	1
STEP PIN RE374000002-1	1	1
DRILLING		
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED
NOSE ADAPTER RE574000002-1	1	1
COOLANT BUSHING RE574000002-1	1	1
DRILL TFIM25.0253	-199	-239
REAMING SKIN AND SUBSTRUCTURE		
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED
NOSE ADAPTER RE574000002-1	1	1
COOLANT BUSHING RE574000002-1	1	1
REMER TFIM25.121	1	1
COUNTERSINKING SKIN		
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP
MICROSTOP CAGE	STANDARD	STANDARD
COUNTERSINK BODY TFIM25.0120	-126 1 1	-158 1 1
CARBIDE INSERT TFIM25.0121	-492	-492

LEGEND

1 NOT REQUIRED

Figure 9. Close Tolerance Hole Fabrication, Repair 16

REPAIR 17



HOLE COLOR CODE	PINK
HOLE SIZE	5/16 FIRST OVS. SECOND OVS.
POTTING	
BUSHING LINER RE374000002-1 UPPER/LOWER-1	-140/-103
STEP PIN RE374000002-1	-250 -248 -249
DRILLING	
DRILLING MACHINE	74D110313-1001 265 RPM HYDRAULIC FEED
NOSE ADAPTER RE574000002-1	-123
BUSHING RE574000002-1 UPPER/LOWER	-GL/-534
DRILL TFIM25.0253	-705
REAMING PRE-CLASS 1 HOLE IN SKIN	
DRILLING MACHINE	74D110313-1001 265 RPM HYDRAULIC FEED
NOSE ADAPTER RE574000002-1	-TBD
BUSHING RE574000002-1 UPPER/LOWER	 -DW/-535 -DX/-536
REAMER TFIM25.121	 -3236 -3392

Figure 10. Close Tolerance Hole Fabrication, Repair 17 (Sheet 1)

REPAIR 17 (CONTINUED)

HOLE COLOR CODE	PINK
HOLE SIZE	5/16 FIRST OVS. SECOND OVS.
REAMING SKIN, CLASS 1 HOLE	
DRILLING MACHINE	500 RPM PISTOL GRIP
REAMER TFIM25.126	-3122 -3278 -3434
COUNTERSINKING SKIN	
DRILLING MACHINE	2000 RPM PISTOL GRIP
MICROSTOP CAGE	STANDARD
COUNTERSINK BODY	-309 -324 -340
CARBIDE INSERT TFIM25.0121	-493

LEGEND

1	NOT REQUIRED
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Figure 10. Close Tolerance Hole Fabrication, Repair 17 (Sheet 2)

DEPOT MAINTENANCE

STRUCTURE REPAIR

SHOP PRACTICES

CLOSE TOLERANCE HOLE FABRICATION, REPAIR NUMBERS 21 THRU 30B

Reference Material

Structure Repair, General Information	A1-F18AC-SRM-200
Fastener Hole Classification Data	WP004 15

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Repair 27	2
Repair 28	2
Repair 29	2
Repair 29A	2
Repair 30	2
Repair 30A	2
Repair 30B	2

Record of Applicable Technical Directives

None

1. CLOSE TOLERANCE HOLE
FABRICATION.

2. This work package provides guidelines to depot personnel for correct selection of tools and equipment required for close tolerance hole fabrication. To make sure hole integrity is maintained, use of repair numbers is required. For fastener hole classification data, (WP004 15).

3. **REPAIR 21.** Data to be supplied when available.

4. **REPAIR 22.** Data to be supplied when available.

5. **REPAIR 23.** Data to be supplied when available.

6. **REPAIR 24.** See figure 1. Repair 24 is for interference fit holes in graphite epoxy skin and interference fit holes in aluminum substructure more than 0.150 inch thick.

7. **REPAIR 25.** See figure 2. Repair 25 is for class 1 holes in graphite epoxy skin and class 1 holes in aluminum substructure more than 0.150 inch thick.

8. **REPAIR 26.** See figure 3. Repair 26 is for class 2 holes in graphite epoxy skin and interference fit holes in aluminum substructure more than 0.150 inch thick.

9. **REPAIR 26A.** See figure 4. Repair 26A is for class 2 holes in graphite epoxy skin and interference fit holes in aluminum substructure more than 0.150 inch thick.

10. **REPAIR 27.** See figure 5. Repair 27 is for class 2 holes in graphite epoxy skin and class 2, cold worked, holes in aluminum substructure more than 0.150 inch thick.

11. **REPAIR 28.** See figure 6. Repair 28 is for class 2 holes in graphite epoxy skin and class 2, stress coined, holes in aluminum substructure more than 0.150 inch thick.

12. **REPAIR 29.** See figure 7. Repair 29 is for class 2G holes in graphite epoxy skin and class 2G holes in aluminum substructure more than 0.150 inch thick.

13. **REPAIR 29A.** See figure 8. Repair 29A is for class 2G holes in graphite epoxy skin and class 2G holes in aluminum substructure more than 0.150 inch thick.

14. **REPAIR 30.** See figure 9. Repair 30 is for class 2G holes in graphite epoxy skin and class 2G holes in aluminum substructure for force mated bushings in flap drive flange.

15. **REPAIR 30A.** See figure 10. Repair 30A is for class 2G holes in graphite epoxy skin and class 2G, cold worked, holes in aluminum substructure.

16. **REPAIR 30B.** See figure 11. Repair 30B is for class 2G holes in graphite epoxy skin and class 2G, cold worked, holes in aluminum substructure.

REPAIR 24

HOLE COLOR CODE	GREEN	PINK
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.
POTTING		
BUSHING LINER RE374000002-1	-103	-103
STEP PIN RE374000002-1	-104 PILOT -192 -193 -194	-104 PILOT -206 -207 -208
DRILLING		
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED
NOSE ADAPTER RE574000002-1	1	1
COOLANT BUSHING RE574000002-1	-223	-220
DRILL TFIM25.0253	-234	-296
REAMING SKIN AND SUBSTRUCTURE		
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED
NOSE ADAPTER RE574000002-1	1	1
COOLANT BUSHING RE574000002-1	-413 -424 -425	-426 -427 -428

REPAIR 24 (CONTINUED)

HOLE COLOR CODE	GREEN	PINK
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.
REAMER TFIM25.121	-2455 -2611 -2767	-3093 -3236 -3392
COUNTERSINKING SKIN		
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP
MICROSTOP CAGE	STANDARD	STANDARD
COUNTERSINK BODY TFIM25.0120	-242 -257 -273	-304 -319 -335
CARBIDE INSERT TFIM25.0121	-492	-493

LEGEND

1 NOT REQUIRED

Figure 1. Close Tolerance Hole Fabrication, Repair 24

REPAIR 25

HOLE COLOR CODE	ORANGE	GREEN	PINK	VIOLET
HOLE SIZE	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.
POTTING				
BUSHING LINER RE374000002-1	-179	-103	-103	-101
STEP PIN RE374000002-1	-104 PILOT 1 1 1	-104 PILOT -105 -106 -107	-104 PILOT -108 -109 -110	-111 PILOT -112 -113 -114
DRILLING				
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110314-1001 1100-450 RPM HYDRO CHECK FEED
NOSE ADAPTER RE574000002-1	1	1	1	-231
COOLANT BUSHING RE574000002-1	-410	-223	-220	-C
DRILL TFIM25.0235	-185	-234	-296	-359
REAMING INTERFERENCE HOLES IN SKIN AND SUBSTRUCTURE				
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110314-1009 250 RPM HYDRO CHECK FEED
NOSE ADAPTER RE574000002-1	1	1	1	-232
COOLANT BUSHING RE574000002-1	1 -421 -422	-413 -424 -425	-426 -427 -428	-DL -DM -DN
REAMER TFIM25.121	1 -1986 -2142	-2455 -2611 -2767	-3093 -3236 -3392	-3705 -3861 -4017
REAMING CLASS 1 HOLES IN SKIN				
DRILLING MACHINE	500 RPM PISTOL GRIP	500 RPM PISTOL GRIP	500 RPM PISTOL GRIP	500 RPM PISTOL GRIP
REAMER TFIM25.126	-1897 -2028 -2184	-2497 -2653 -2809	-3122 -3278 -3434	-3747 -3903 -4059

Figure 2. Close Tolerance Hole Fabrication, Repair 25 (Sheet 1)

REPAIR 25 (CONTINUED)

HOLE COLOR CODE	ORANGE	GREEN	PINK	VIOLET
HOLE SIZE	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.
COUNTERSINKING SKIN				
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP
MICROSTOP CAGE	STANDARD	STANDARD	STANDARD	STANDARD
COUNTERSINK BODY TFIM25.0120	-187 -200 -215	-247 -264 -278	-309 -324 -340	-367 -387 -403
CARBIDE INSERT TFIM25.0121	-492	-492	-493	-493

LEGEND


1 NOT REQUIRED

REPAIR 26

HOLE COLOR CODE	SILVER	ORANGE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	5/32 FIRST OVS. SECOND OVS.	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING						
BUSHING LINER RE374000002-1	1	1	-103	-103	-101	1
STEP PIN RE374000002-1	1 1 1	1 1 1	-104 PILOT 1 1 1	-104 PILOT 1 1 1	-111 PILOT 1 1 1	1 1 1
DRILLING						
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110314-1001 1100-450 RPM POSITIVE FEED	74D110314-1001 1100-450 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	1	1	-231	1
COOLANT BUSHING RE574000002-1	1	1	-223	-220	-C	1
DRILL TFIM25.0235	-161	-185	-234	-296	-359	-421
REAMING INTERFERENCE HOLES IN SKIN AND SUBSTRUCTURE						
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	1	1	-232	1
COOLANT BUSHING RE574000002-1	1 1 1	1 1 1	-413 -424 -425	-426 -427 -428	-DL -DM -DN	1 1 1
REAMER TFIM25.121	1 1 1	1 -1986 -2142	-2455 -2611 -2767	-3093 -3236 -3392	-3705 -3861 -4017	-4330 -4486 -4642
REAMING CLASS 2 HOLES IN SKIN						
DRILLING MACHINE	500 RPM PISTOL GRIP	500 RPM PISTOL GRIP	500 RPM PISTOL GRIP	500 RPM PISTOL GRIP	500 RPM PISTOL GRIP	500 RPM PISTOL GRIP
REAMER TFIM25.126	-1643 1 1	-1903 -2034 -2190	-2504 -2659 -2815	-3129 -3285 -3441	-3754 -3910 -4066	-4379 -4535 -4690
FREE HAND COUNTERSINKING						
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP
MICROSTOP CAGE	STANDARD	STANDARD	STANDARD	STANDARD	STANDARD	STANDARD

Figure 3. Close Tolerance Hole Fabrication, Repair 26 (Sheet 1)

REPAIR 26 (CONTINUED)

HOLE COLOR CODE	SILVER	ORANGE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	5/32 FIRST OVS. SECOND OVS.	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
COUNTERSINKING SKIN						
COUNTERSINK BODY TFIM25.0120	-161 	-187 -200 -215	-247 -262 -278	-309 -324 -340	-367 -387 -403	-429 -450 -465
CARBIDE INSERT TFIM25.0121	-492	-492	-492	-493	-493	-497

LEGEND

 NOT REQUIRED

REPAIR 26A

HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING				
BUSHING LINER RE374000002-1	-198	-199	-200	1
STEP PIN RE374000002-1	-104 PILOT 1 1 1	-104 PILOT 1 1	-111 PILOT 1 1 1	1 1 1
ADAPTER BUSHING RE374000002-1	-158	-158	-159	1
DRILLING				
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110314-1001 1000-450 RPM POSITIVE FEED	74D110314-1001 1000-450 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	-314	1
COOLANT BUSHING RE574000002-1	-223	-220	-BR	1
DRILL TFIM25.0235	-234	-296	-359	-421
REAMING SKIN AND SUBSTRUCTURE				
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	-313	1
COOLANT BUSHING RE574000002-1	-413 -424 -425	-426 -427 -428	-EJ -GR -EL	1 1 1
REAMER TFIM25.121	-2455 -2611 -2767	-3093 -3236 -3392	-3705 -3861 -4017	-4330 -4486 -4642

Figure 4. Close Tolerance Hole Fabrication, Repair 26A (Sheet 1)

REPAIR 26A (CONTINUED)

HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
REAMING SKIN				
DRILLING MACHINE	500 RPM PISTOL GRIP	500 RPM PISTOL GRIP	500 RPM PISTOL GRIP	500 RPM PISTOL GRIP
REAMER TFIM25.126	-2504 -2659 -2815	-3129 -3285 -3441	-3754 -3910 -4066	-4379 -4535 -4690
COUNTERSINKING THROUGH DRILL PLATE 3				
DRILLING MACHINE	74D110312-1001 1000 RPM RACK FEED	74D110312-1001 1000 RPM RACK FEED	74D110312-1001 1000 RPM RACK FEED	74D110312-1001 1000 RPM RACK FEED
COUNTERSINK SUBASSEMBLY RE574000002-1	-BG	-BH	-B	1
COUNTERSINK CUTTERS				
COUNTERSINK BODY TFIM25.0120	-247 -262 -278	-309 -324 -340	-367 -387 -403	-429 -450 -465
CARBIDE INSERT TFIM25.0121	-492	-493	-493	-497

LEGEND

- 1 NOT REQUIRED.
- 2 ADAPTER BUSHING USED FOR POTTING
BUSHING LINERS ONLY, NOT USED
WITH DRILLING MACHINES.
- 3 SEE TABLE 1.

TABLE 1. HOLES REQUIRING COUNTERSINKING THROUGH DRILL PLATE

SKIN P/N	HOLE NUMBERS
74110600	235-250, 927-931, 933-978 AND 1001-1004
74A110601	174-189, 861-864, 951-1001 AND 1438-1441
74A150600	1-81 AND 195-204
74A150601	1-47, 58-76, 159-180, 383 384, 437, AND 438

REPAIR 27

HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING				
BUSHING LINER RE374000002-1	-103	-103	-101	-102
STEP PIN RE374000002-1	-104 PILOT 1 1 1	-104 PILOT 1 1 1	-111 PILOT 1 1 1	-115 PILOT -116 -117 -118
DRILLING				
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110314-1001 1100-450 RPM POSITIVE FEED	74D110314-1001 1100-450 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	-231	-231
COOLANT BUSHING RE574000002-1	-389	-392	1	DH
DRILL TFIM25.0253	-218	-281	-343	-406
REAMING PRE-COLD WORKED HOLES IN SKIN AND SUBSTRUCTURE 2				
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	-232	-232
COOLANT BUSHING RE574000002-1	-390 -101 -391	-393 -104 -394	-C -E -CV	-DP -DR -R
REAMER TFIM25.121	-2352 -2510 -2669	-2972 -3135 -3255	-3592 -3760 -3919	-4212 -4373 -4534
REAMING CLASS 2 HOLES IN SKIN				
DRILLING MACHINE	500 RPM PISTOL GRIP	500 RPM PISTOL GRIP	250 RPM PISTOL GRIP	250 RPM PISTOL GRIP
REAMER TFIM25.126	-2503 -2659 -2815	-3128 -3284 -3440	-3753 -3909 -4065	-4378 -4534 -4690

Figure 5. Close Tolerance Hole Fabrication, Repair 27 (Sheet 1)

REPAIR 27

HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
REAMING CLASS 2 HOLE IN SUBSTRUCTURE				
DRILLING MACHINE	1000 RPM PISTOL GRIP	500 RPM PISTOL GRIP	250 RPM PISTOL GRIP	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	1	-232
COOLANT BUSHING RE574000002-1	1 1 1	1 1 1	1 1 1	-CY -S -U
REAMER TFIM25.111	-2497 -2653 -2809	-3122 -3278 -3434	-3747 -3903 -4059	-4372 -4528 -4684
COUNTERSINKING SKIN				
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP
MICROSTOP CAGE	STANDARD	STANDARD	STANDARD	STANDARD
COUNTERSINK CUTTER				
COUNTERSINK BODY TFIM25.0121	-247 -262 -278	-309 -324 -340	-372 -387 -403	-434 -450 -465
CARBIDE INSERT TFIM25.0121	-492	-493	-493	-497

LEGEND

- 1 NOT REQUIRED.
- 2 AFTER REAMING, COLDWORK SUBSTRUCTURE USING RE174000002-1 FASTENER HOLE COLDWORKING TOOL SET.

REPAIR 28

HOLE COLOR CODE	GREEN	PINK
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.
POTTING		
BUSHING LINER RE374000002-1	-103	-103
STEP PIN RE374000002-1	-104 PILOT 1 1 1	-104 PILOT 1 1 1
DRILLING		
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED
NOSE ADAPTER RE574000002-1	1	1
COOLANT BUSHING RE574000002-1	-223	-220
DRILL TFIM25.0253	-234	-296
REAMING PRE-STRESS COIN HOLES IN SKIN AND SUBSTRUCTURE 2		
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED
NOSE ADAPTER RE574000002-1	1	1
COOLANT BUSHING RE574000002-1	-434 -435 -436	-426 -394 -437
REAMER TFIM25.121	-2473 -2623 -2783	-3093 -3255 -3403
REAMING CLASS 2 HOLES IN SKIN		
DRILLING MACHINE	250 RPM PISTOL GRIP	150 RPM PISTOL GRIP
REAMER TFIM25.126	-2504 -2659 -2815	-3129 -3285 -3441

REPAIR 28 (CONTINUED)

HOLE COLOR CODE	GREEN	PINK
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.
COUNTERSINKING SKIN		
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP
NOSE ADAPTER RE574000002-1	1	1
COOLANT BUSHING RE574000002-1	1	1
MICROSTOP CAGE	STANDARD	STANDARD
COUNTERSINK BODY TFIM25.0120	-247 -262 -278	-309 -324 -340
CARBIDE INSERT TFIM25.0121	-492	-493

LEGEND

- 1 NOT REQUIRED
- 2 AFTER REAMING, STRESS COIN HOLES IN SUBSTRUCTURE USING RE174000002-1 FASTENER HOLE COLD WORKING TOOL SET.

Figure 6. Close Tolerance Hole Fabrication, Repair 28

REPAIR 29

HOLE COLOR CODE	ORANGE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING					
BUSHING LINER RE374000002-1	1	-103	-103	-101	-102
STEP PIN RE374000002-1	1 1 1	-104 PILOT -105 -106 -107	-104 PILOT -108 -109 -110	-111 PILOT -112 -113 -114	-115 PILOT -116 -117 -118
DRILLING					
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110314-1001 1100-450 RPM POSITIVE FEED	74D110314-1001 1100-450 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	1	-231	-231
COOLANT BUSHING RE574000002-1	1	-223	-220	-C	-L
DRILL TFIM25.0235	-117	-234	-296	-359	-421
REAMING SKIN AND SUBSTRUCTURE					
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	1	-232	-232
COOLANT BUSHING RE574000002-1	1 1 1	-101 -102 -103	-104 -105 -106	-E -G -J	-N -R -T
REAMER TFIM25.121	-1910 -2034 -2190	-2510 -2659 -2815	-3135 -3284 -3440	-3760 -3909 -4065	-4385 -4534 -4690
FREE HAND COUNTERSINKING					
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP
MICROSTOP CAGE	STANDARD	STANDARD	STANDARD	STANDARD	STANDARD

Figure 7. Close Tolerance Hole Fabrication, Repair 29 (Sheet 1)

REPAIR 29 (CONTINUED)

HOLE COLOR CODE	ORANGE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
COUNTERSINK CUTTER					
COUNTERSINK BODY TFIM25.0120	-187 -200 -215	-247 -262 -278	-309 -324 -340	-372 -387 -403	-434 -450 -465
CARBIDE INSERT TFIM25.0120	-492	-492	-493	-493	-497

LEGEND


 NOT REQUIRED

Figure 7. Close Tolerance Hole Fabrication, Repair 29 (Sheet 2)

REPAIR 29A










HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING				
BUSHING LINER RE374000002-1	-198	-199	-200	-201
STEP PIN RE374000002-1	-104 PILOT 	-104 PILOT 	-111 PILOT 	-15 PILOT 
ADAPTER BUSHING RE374000002-1	-158	-158	-159	-160
DRILLING				
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110314-1001 1100 - 450 RPM POSITIVE FEED	74D110314-1001 1100 - 450 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1			-231	-231
COOLANT BUSHING RE574000002-1	-223	-220	-BR	-BL
DRILL TFIM25.0235	-234	-209	-359	-421
REAMING SKIN AND SUBSTRUCTURE				
DRILL MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1			-232	-232
COOLANT BUSHING RE574000002-1	-101 -102 -103	-104 -105 -106	-BS -BJ -BK	-BM -BN -BP
REAMER TFIM25.121	-2510 -2659 -2815	-3135 -3284 -2815	-3760 -3909 -4064	-4385 -4534 -4690

Figure 8. Close Tolerance Hole Fabrication, Repair 29A (Sheet 1)

REPAIR 29A (CONTINUED)

HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
COUNTERSINKING THROUGH DRILL PLATE 				
DRILLING MACHINE	74D110312-1001 1000 RPM RACK FEED	74D110312-1001 1000 RPM RACK FEED	74D110312-1001 1000 RPM RACK FEED	74D110312-1001 1000 RPM RACK FEED
COUNTERSINK SUBASSEMBLY RE574000002-1	-BG	-BH	-B	-A
COUNTERSINKING SKIN				
COUNTERSINK SUBASSEMBLY RE574000002-1	-247 -262 -278	-309 -324 -340	-372 -387 -403	-434 -450 -465
CARBIDE INSERT TF1M25.0121	-492	-493	-493	-497

LEGEND










-  NOT REQUIRED.
-  ADAPTER BUSHING USED FOR POTTING BUSHING LINERS ONLY, NOT USED WITH DRILLING MACHINES.
-  SEE TABLE 1.





TABLE 1. HOLES REQUIRING COUNTERSINKING THROUGH DRILL PLATE

SKIN P/N	HOLE NUMBERS
74A110600	235-250, 927-931, 933-978, AND 1001-1004
74A110601	174-189, 861-864, 951-1001, AND 1438-1441
74A150600	1-81 AND 195-204
74A150601	1-47, 58-76, 159-180, 383, 384, 437, AND 438

REPAIR 30

HOLE COLOR CODE	SILVER
HOLE SIZE	5/32 FIRST OVS. SECOND OVS.
POTTING	
BUSHING LINER RE374000002-1	-201
STEP PIN RE374000002-1	-115 PILOT -116 -117 -118
ADAPTER BUSHING  RE374000002-1	-160
DRILLING	
DRILLING MACHINE	74D110314-1001 2000 RPM HYDRO CHECK FEED
NOSE ADAPTER RE574000002-1	-314
COOLANT BUSHING RE574000002-1	-BL
DRILL TFIM25.0253	-421
CORE DRILL SUBSTRUCTURE	
DRILLING MACHINE	250 RPM PISTOL GRIP
NOSE ADAPTER RE574000002-1	
COOLANT BUSHING RE574000002-1	  
DRILL SPT-74A110600	-5001
 REAMING SUBSTRUCTURE	
DRILLING MACHINE	200 RPM PISTOL GRIP
REAMER SPT2-74A110600	-5001
REAMING SKIN AND SUBSTRUCTURE (BUSHINGS)	
DRILLING MACHINE	74D110314-1009 250 RPM POSITIVE FEED

REPAIR 30 (CONTINUED)

HOLE COLOR CODE	SILVER
HOLE SIZE	5/32 FIRST OVS. SECOND OVS.
NOSE ADAPTER RE574000002-1	-313
COOLANT BUSHING RE574000002-1	-BL -BM 
REAMER PSMT-1662	-1
FINAL REAMING OF SKIN AND SUBSTRUCTURE	
DRILLING MACHINE	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	-313
COOLANT BUSHING RE574000002-1	-BL -BM 
REAMER TFIM25.121	-4385  
COUNTERSINKING SKIN THROUGH DRILL PLATE	
DRILLING MACHINE	74D110312-1001 1000 RPM RACK FEED
COUNTERSINK SUBASSEMBLY RE574000002-1	-A
COUNTERSINK CUTTER	
COUNTERSINK BODY TFIM25.0120	-434
CARBIDE INSERT TFIM25.0121	-497

LEGEND




-  ADAPTER BUSHING USED FOR POTTING BUSHING LINERS ONLY, NOT USED WITH DRILLING MACHINES.
-  NOT REQUIRED
-  AFTER REAMING, INSTALL AND FORCE MATE BUSHINGS IN SUBSTRUCTURE USING REB74110004-1 INNER WING REPAIR KIT.

Figure 9. Close Tolerance Hole Fabrication, Repair 30

REPAIR 30A

HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING				
BUSHING LINER RE374000002-1	-103	-103	1	1
STEP PIN RE374000002-1	-104 PILOT 1 1 1	-104 PILOT 1 1 1	1 1 1	1 1 1
DRILLING				
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110314-1001 1100-450 RPM POSITIVE FEED	74D110314-1001 1100-450 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	1	1
COOLANT BUSHING RE574000002-1	-389	-392	1	1
DRILL TFIM25.0235	-218	-281	-343	-406
REAMING PRE-COLD WORKED HOLES IN SKIN AND SUBSTRUCTURE 2				
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	1	1
COOLANT BUSHING RE574000002-1	-390 -101 -391	-393 -104 -394	1 1 1	1 1 1
REAMER TFIM25.121	-2352 -2510 -2669	-2972 -3135 -3255	-3592 -3760 -3919	-4212 -4373 -4534
REAMING CLASS 2 HOLES IN SKIN AND SUBSTRUCTURE				
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	1	1
COOLANT BUSHING RE574000002-1	1 1 1	1 1 1	1 1 1	1 1 1
REAMER TFIM25.121	-2510 -2659 -2815	-3135 -3284 -3440	-3760 -3909 -4065	-4385 -4534 -4690

Figure 10. Close Tolerance Hole Fabrication, Repair 30A (Sheet 1)

REPAIR 30A (CONTINUED)

HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
FREE HAND COUNTERSINKING				
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP
MICROSTOP CAGE	STANDARD	STANDARD	STANDARD	STANDARD
COUNTERSINK CUTTERS				
COUNTERSINK BODY TFIM25.0120	-247 -262 -278	-309 -324 -340	-372 -378 -403	-434 -450 -465
CARBIDE INSERT TFIM25.0121	-492	-493	-493	-497

LEGEND

- 1> NOT REQUIRED
- 1> AFTER REAMING, COLD WORK HOLES IN SUBSTRUCTURE USING RE174000002-1 FASTER HOLE COLD WORKING TOOL SET.

REPAIR 30B

HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING				
BUSHING LINER RE374000002-1	1	1	-200	-201
STEP PIN RE374000002-1	1	1	-111 PILOT 1 1 1	-115 PILOT 1 1 1
ADAPTER BUSHING RE374000002-1 2	1	1	-159	-160
DRILLING				
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110314-1001 1100-450 RPM POSITIVE FEED	74D110314-1001 1100-450 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	-314	-314
COOLANT BUSHING RE574000002-1	1	1	-EM	-DH
DRILL TFIM25.0235	-218	-281	-343	-406
REAMING PRE-COLD WORKED HOLES IN SKIN AND SUBSTRUCTURE				
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	-313	-313
COOLANT BUSHING RE574000002-1	1 1 1	1 1 1	-C -E -EN	-DP -DR -R
REAMER TFIM25.121	-2352 -2510 -2669	-2972 -3135 -3255	-3592 -3760 -3919	-4212 -4373 -4534

Figure 11. Close Tolerance Hole Fabrication, Repair 30B (Sheet 1)

REPAIR 30B (CONTINUED)

HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
REAMING CLASS 2G HOLES IN SKIN AND SUBSTRUCTURE				
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1001 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	-313	-313
COOLANT BUSHING RE574000002-1	1	1	-BS -BJ -BK	-BM -BN -BP
REAMER TFIM25.121	-2510 -2659 -2815	-3135 -3284 -3440	-3760 -3990 -4065	-4385 -4534 -4690
COUNTERSINKING THROUGH DRILL PLATE 3				
DRILLING MACHINE	74D110312-1001 1000 RPM RACK FEED	74D110312-1001 1000 RPM RACK FEED	74D110312-1001 1000 RPM RACK FEED	74D110312-1001 1000 RPM RACK FEED
COUNTERSINK SUBASSEMBLY RE574000002-1	-BG	-BH	-B	-A
COUNTERSINKING SKIN				
COUNTERSINK BODY TFIM25.0120	-247 -262 -278	-309 -324 -340	-372 -387 -403	-434 -450 -465
CARBIDE INSERT TFIM25.0121	-492	-493	-493	-497

LEGEND

- 1 NOT REQUIRED.
- 2 ADAPTER BUSHING USED FOR POTTING BUSHING LINERS' ONLY, NOT USED WITH DRILLING MACHINES.
- 3 SEE TABLE 1.

TABLE 1. HOLES REQUIRING COUNTERSINKING THROUGH DRILL PLATE

SKIN P/N	HOLE NUMBERS
74110600	235-250, 927-931, 933-978 AND 1001-1004
74A110601	174-189, 861-864, 951-1001 AND 1438-1441
74A150600	1-81 AND 195-204
74A150601	1-47, 58-76, 159-180, 383 384, 437, AND 438

18AC-SRM-20-(187-2)24-CATI

Figure 11. Close Tolerance Hole Fabrication, Repair 30B (Sheet 2)

DEPOT MAINTENANCE

STRUCTURE REPAIR

SHOP PRACTICES

CLOSE TOLERANCE HOLE FABRICATION, REPAIR NUMBERS 31 THRU 40

Reference Material

Structure Repair, General Information	A1-F18AC-SRM-200
Fastener Hole Classification Data	WP004 15

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Repair 38	2
Repair 39	2
Repair 40	2

Record of Applicable Technical Directives

None

1. CLOSE TOLERANCE HOLE FABRICATION.

2. This work package provides guidelines to depot personnel for correct selection of tools and equipment required for close tolerance hole fabrication. To make sure hole integrity is maintained, use of repair numbers is required. For fastener hole classification data, (WP004 15).

3. **REPAIR 31.** See figure 1. Repair 31 is for class 3 holes in graphite epoxy skin and class 3 holes in aluminum substructure more than 0.150 inch thick.

4. **REPAIR 31A.** See figure 2. Repair 31A is for:

a. Class 3 holes in graphite epoxy skin and class 3, cold worked, holes in aluminum substructure.

b. Class 3, cold worked, holes in aluminum substructure.

5. **REPAIR 32.** See figure 3. Repair 32 is for class D holes in graphite epoxy skin and class D holes in aluminum substructure more than 0.150 inch thick.

6. **REPAIR 33.** See figure 4. Repair 33 is for Jo-Bolt holes in graphite epoxy skin and Jo-Bolt holes in aluminum substructure more than 0.150 inch thick.

7. **REPAIR 34.** See figure 5. Repair 34 is for Jo-Bolt holes in graphite epoxy skin and Jo-Bolt holes, cold worked, in aluminum substructure more than 0.150 inch thick.

8. **REPAIR 35.** See figure 6. Repair 35 is for Olympic-Lok holes in graphite epoxy skin and Olympic-lok holes in aluminum substructure more than 0.150 inch thick.

9. **REPAIR 36.** Data to be supplied when available.

10. **REPAIR 37.** Data to be supplied when available.

11. **REPAIR 38.** Data to be supplied when available.

12. **REPAIR 39.** Data to be supplied when available.

13. **REPAIR 40.** See figure 7. Repair 40 is for class 1 holes in graphite epoxy bonded to titanium skin.

REPAIR 31

HOLE COLOR CODE	ORANGE	GREEN	PINK	VIOLET
HOLE SIZE	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.
POTTING				
BUSHING LINER RE374000002-1	1	-103	-103	-101
STEP PIN RE374000002-1	1 1 1	-104 PILOT -105 -106 -107	-104 PILOT -108 -109 -110	-111 PILOT -186 -113 -114
DRILLING				
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110314-1001 1100-450 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	1	-231
COOLANT BUSHING RE574000002-1	1	-229	-230	-AY
DRILL TFIM25.0235	-191	-252	-315	-377
REAMING SKIN AND SUBSTRUCTURE				
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110314-1001 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	1	-232
COOLANT BUSHING RE574000002-1	1 1 1	1 -102 -103	1 -105 -106	1 -G -J
REAMER TFIM25.121	1 -2083 -2239	1 -2659 -2815	1 -3284 -3440	1 -3909 -4065

Figure 1. Close Tolerance Hole Fabrication, Repair 31 (Sheet 1)

REPAIR 31 (CONTINUED)

HOLE COLOR CODE	ORANGE	GREEN	PINK	VIOLET
HOLE SIZE	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.
COUNTERSINKING SKIN				
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP
MICROSTOP CAGE RE574000002-1	STANDARD	STANDARD	STANDARD	STANDARD
COUNTERSINK BODY TFIM25.0120	-187 -200 -215	-247 -262 -278	-309 -324 -340	-372 -387 -403
CARBIDE INSERT TFIM25.0121	-492	-492	-493	-493

LEGEND

1 NOT REQUIRED

REPAIR 31A

HOLE COLOR CODE	GREEN	PINK	VIOLET
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.
POTTING			
BUSHING LINER RE374000002-1	1	-103	1
STEP PIN RE374000002-1	1 1 1	-104 PILOT -108 -109 -110	1 1 1
DRILLING			
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110314-1001 1100-450 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	1
COOLANT BUSHING RE574000002-1	1	-392	1
DRILL TFIM25.0235	-218	-281	-343
REAMING PRE-COLD WORKED HOLES IN SKIN AND SUBSTRUCTURE 2			
DRILLING MACHINE	74D110316-1001 500 RPMM HYDRO CHECK FEED	74D110316-1001 500 RPMM HYDRO CHECK FEED	74D110314-1001 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	1
COOLANT BUSHING RE574000002-1	1 1 1	-393 -104 -394	1 1 1
REMER TFIM25.121	-2352 -2510 -2669	-2972 -3135 -3255	-3592 -3760 -3919
REAMING CLASS 3 HOLES IN SKIN AND SUBSTRUCTURE			
DRILLING MACHINE	74D110316-1001 500 RPMM HYDRO CHECK FEED	74D110316-1001 500 RPMM HYDRO CHECK FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	1
COOLANT BUSHING RE574000002-1	1 1 1	-104 -105 -106	1 1 1
REMER TFIM25.121	-2510 -2659 -2815	-3135 -3284 -3440	-3760 -3990 -4065

Figure 2. Close Tolerance Hole Fabrication, Repair 31A (Sheet 1)

REPAIR 31A (CONTINUED)

HOLE COLOR CODE	GREEN	PINK	VIOLET
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.
COUNTERSINKING SKIN			
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP
MICROSTOP CAGE	STANDARD	STANDARD	STANDARD
COUNTERSINK BODY TFIM25.0120	-247 -262 -278	-309 -324 -340	-372 -387 -403
CARBIDE INSERT TFIM25.0121	-492	-493	-493

LEGEND

- 1 NOT REQUIRED
- 2 AFTER REAMING, COLD WORK HOLES IN SUBSTRUCTURE USING RE174000002-1 FASTENER HOLE COLD WORKING TOOL SET

REPAIR 32

HOLE COLOR CODE	ORANGE	GREEN	PINK
HOLE SIZE	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.
POTTING			
BUSHING LINER RE374000002-1	-TBD	-103	-103
STEP PIN RE374000002-1	-TBD -TBD -TBD	-104 PILOT -105 -106 -107	-104 PILOT -108 -109 -110
DRILLING			
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED
NOSE ADAPTER RE574000002-1	1	1	1
COOLANT BUSHING RE574000002-1	-TBD	-TBD	-TBD
DRILL TFIM25.0235	-191	-252	-315
REAMING SKIN AND SUBSTRUCTURE			
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED
NOSE ADAPTER RE574000002-1	1	1	1
COOLANT BUSHING RE574000002-1	-TBD -TBD -TBD	-TBD -TBD -TBD	-TBD -TBD -TBD
REAMER TFIM25.121	-1960 -2083 -2239	-2608 -2708 -2864	-3236 -3378 -3534

Figure 3. Close Tolerance Hole Fabrication, Repair 32 (Sheet 1)

REPAIR 32 (CONTINUED)

HOLE COLOR CODE	ORANGE	GREEN	PINK
HOLE SIZE	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.
COUNTERSINKING SKIN			
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP
NOSE ADAPTER RE574000002-1	1	1	1
COOLANT BUSHING RE574000002-1	1	1	1
MICROSTOP CAGE RE574000002-1	STANDARD	STANDARD	STANDARD
COUNTERSINK BODY TFIM25.0120	-192 -205 -221	-252 -268 -283	-319 -335 -350
CARBIDE INSERT TFIM25.0121	-492	-492	-493

LEGEND

1 NOT REQUIRED

REPAIR 33

HOLE COLOR CODE	SILVER	ORANGE	GREEN
HOLE SIZE	5/32 FIRST OVS. SECOND OVS.	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.
POTTING			
BUSHING LINER RE374000002-1	-TBD	-TBD	-103
STEP PIN RE374000002-1	-TBD -TBD -TBD	-TBD -TBD -TBD	-104 PILOT -105 -106 -107
DRILLING			
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED
NOSE ADAPTER RE574000002-1	1	1	1
COOLANT BUSHING RE574000002-1	-TBD	-TBD	-TBD
DRILL TFIM25.0235	-152	-191	-252
REAMING SKIN AND SUBSTRUCTURE			
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED
NOSE ADAPTER RE574000002-1	1	1	1
COOLANT BUSHING RE574000002-1	-TBD -TBD -TBD	-TBD -TBD -TBD	-TBD -TBD -TBD
REAMER TFIM25.121	-1650 -1808 -TBD	-1998 -2158 -TBD	-2608 -2767 -TBD

Figure 4. Close Tolerance Hole Fabrication, Repair 33 (Sheet 1)

REPAIR 33 (CONTINUED)

HOLE COLOR CODE	SILVER	ORANGE	GREEN
HOLE SIZE	5/32 FIRST OVS. SECOND OVS.	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.
COUNTERSINKING SKIN			
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP
NOSE ADAPTER RE574000002-1	1	1	1
COOLANT BUSHING RE574000002-1	1	1	1
MICROSTOP CAGE RE574000002-1	STANDARD	STANDARD	STANDARD
COUNTERSINK BODY TFIM25.0120	-161 -177 -TBD	-196 -212 -TBD	-257 -273 -TBD
CARBIDE INSERT TFIM25.0121	-492	-492	-492

LEGEND

1 NOT REQUIRED

REPAIR 34

HOLE COLOR CODE	SILVER	ORANGE
HOLE SIZE	5/32 FIRST OVS. SECOND OVS.	3/16 FIRST OVS. SECOND OVS.
POTTING		
BUSHING LINER RE374000002-1	-TBD	-TBD
STEP PIN RE374000002-1	-TBD -TBD -TBD	-TBD -TBD -TBD
DRILLING		
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED
NOSE ADAPTER RE574000002-1	1	1
COOLANT BUSHING RE574000002-1	-TBD	-TBD
DRILL TFIM25.0235	-128	-166
REAMING PRE-COLD WORKED HOLES IN SKIN AND SUBSTRUCTURE 2		
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED
NOSE ADAPTER RE574000002-1	1	1
COOLANT BUSHING RE574000002-1	-TBD -TBD -TBD	-TBD -TBD -TBD
REAMER TFIM25.121	-1432 -TBD -TBD	-1772 -TBD -TBD

REPAIR 34 (CONTINUED)

HOLE COLOR CODE	SILVER	ORANGE
HOLE SIZE	5/32 FIRST OVS. SECOND OVS.	3/16 FIRST OVS. SECOND OVS.
REAMING SKIN AND SUBSTRUCTURE, TWICE		
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED
NOSE ADAPTER RE574000002-1	1	1
COOLANT BUSHING RE574000002-1	-TBD -TBD -TBD	-TBD -TBD -TBD
FIRST REAMER TFIM25.121	-1605 -TBD -TBD	-1910 -TBD -TBD
SECOND REAMER TFIM25.121	-1650 -TBD -TBD	-1998 -TBD -TBD
COUNTERSINKING SKIN		
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP
NOSE ADAPTER RE574000002-1	1	1
COOLANT BUSHING RE574000002-1	1	1
MICROSTOP CAGE RE574000002-1	STANDARD	STANDARD
COUNTERSINK BODY TFIM25.0120	-161 -TBD -TBD	-196 -TBD -TBD
CARBIDE INSERT TFIM25.0121	-492	-492

LEGEND

- 1 NOT REQUIRED
- 2 AFTER REAMING, COLD WORK HOLES IN SUBSTRUCTURE USING RE174000002-1 FASTENER HOLE COLD WORKING TOOL SET

Figure 5. Close Tolerance Hole Fabrication, Repair 34

REPAIR 35

HOLE COLOR CODE	SILVER
HOLE SIZE	5/32 FIRST OVS. SECOND OVS.
POTTING	
BUSHING LINER RE374000002-1	-TBD
STEP PIN RE374000002-1	-TBD -TBD -TBD
DRILLING	
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED
NOSE ADAPTER RE574000002-1	1
COOLANT BUSHING RE574000002-1	-TBD -TBD -TBD
DRILL TFIM25.0235	-161
COUNTERSINKING SKIN	
DRILLING MACHINE	2000 RPM PISTOL GRIP
NOSE ADAPTER RE574000002-1	1
COOLANT BUSHING RE574000002-1	1
MICROSTOP CAGE RE574000002-1	STANDARD
COUNTERSINK BODY TFIM25.0120	-158 -TBD -TBD
CARBIDE INSERT TFIM25.0121	-492

LEGEND

1 NOT REQUIRED

Figure 6. Close Tolerance Hole Fabrication, Repair 35

REPAIR 40

HOLE COLOR CODE	GREEN	PINK	VIOLET
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.
POTTING			
BUSHING LINER RE374000002-1	-140	-141	-TBD
STEP PIN RE374000002-1	-105 -106 -107	-143 -144 -145	-TBD -TBD -TBD
DRILLING			
DRILLING MACHINE	74D110314-1003 640-265 RPM POSITIVE FEED	74D110314-1003 640-265 RPM POSITIVE FEED	74D110314-1003 640-265 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	-221	-221	-TBD
COOLANT BUSHING RE574000002-1	-AA	-AJ	-TBD
DRILL TFIM25.0235	-234	-296	-359
REAMING PRE-CLASS 1 HOLE IN SKIN			
DRILLING MACHINE	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	-123	-123	-TBD
COOLANT BUSHING RE574000002-1	-DS -DT -DU	-DV -DW -DX	-TBD -TBD -TBD
REAMER TFIM25.121	-2455 -2611 -2767	-3093 -3236 -3392	-3705 -3861 -4017
REAMING CLASS 1 HOLES IN SKIN			
DRILLING MACHINE	250 RPM PISTOL GRIP	250 RPM PISTOL GRIP	250 RPM PISTOL GRIP
REAMER TFIM25.126	-2497 -2653 -2809	-3122 -3278 -3434	-3747 -3903 -4059

Figure 7. Close Tolerance Hole Fabrication, Repair 40 (Sheet 1)

REPAIR 40 (CONTINUED)

HOLE COLOR CODE	GREEN	PINK	VIOLET
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.
COUNTERSINKING SKIN			
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	74D110312-1001 1000 RPM RACK FEED
NOSE ADAPTER RE574000002-1	1	1	-TBD
COOLANT BUSHING RE574000002-1	1	1	-TBD
MICROSTOP CAGE RE574000002-1	STANDARD	STANDARD	-TBD
COUNTERSINK BODY TFIM25.0120	-247 -262 -278	-309 -324 -340	-367 -387 -403
CARBIDE INSERT TFIM25.0121	-492	-493	-493

LEGEND

1 NOT REQUIRED

DEPOT MAINTENANCE

STRUCTURE REPAIR

SHOP PRACTICES

CLOSE TOLERANCE HOLE FABRICATION, REPAIR NUMBERS 41 THRU 50

Reference Material

Structure Repair, General Information	A1-F18AC-SRM-200
Fastener Hole Classification Data	WP004 15

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Record of Applicable Technical Directives

None

1. CLOSE TOLERANCE HOLE FABRICATION.

2. This work package provides guidelines to depot personnel for correct selection of tools and equipment required for close tolerance hole fabrication. To make sure hole integrity is maintained, use of repair numbers is required. For fastener hole classification data, (WP004 15).

3. **REPAIR 41.** See figure 1. Repair 41 is for:

a. Class 1 holes in graphite epoxy bonded to titanium skin and interference fit holes in aluminum or titanium substructure.

b. Class 1 holes in graphite epoxy skin and interference fit holes in titanium substructure.

c. Class 1 holes in graphite epoxy skin and interference fit holes in aluminum and titanium substructure.

4. **REPAIR 42.** See figure 2. Repair 42 is for:

- a. Class 2 holes in graphite epoxy bonded to titanium skin.
- b. Class 2 holes in graphite epoxy skin and class 2 holes in aluminum or titanium substructure.

5. **REPAIR 43.** See figure 3. Repair 43 is for:

- a. Class 2 holes in graphite epoxy bonded to titanium skin and interference fit holes in aluminum or titanium substructure.
- b. Class 2 holes in graphite epoxy skin and interference fit holes in titanium substructure.
- c. Class 2 holes in graphite epoxy skin and interference fit holes in titanium and aluminum substructure.

6. **REPAIR 43A.** See figure 4. Repair 43A is for:

- a. Class 2 holes in graphite epoxy bonded to titanium skin and interference fit holes in aluminum or titanium substructure.
- b. Class 2 holes in graphite epoxy skin and interference fit holes in titanium substructure.
- c. Class 2 holes in graphite epoxy skin and interference fit holes in titanium and aluminum substructure.

7. **REPAIR 44.** See figure 5. Repair 44 is for:

- a. Class 2 holes in graphite epoxy bonded to titanium skin and class 2 cold worked, holes in aluminum or titanium substructure.
- b. Class 2 holes in graphite epoxy skin and class 2 cold worked, holes in titanium substructure.

8. **REPAIR 45.** See figure 6. Repair 45 is for class 2 holes in graphite epoxy skin and class 2 stress coined holes in titanium substructure.

9. **REPAIR 46.** See figure 7. Repair 46 is for:

- a. Class 2G holes in graphite epoxy bonded to titanium skin.
- b. Class 2G holes in graphite epoxy bonded to titanium skin and class 2G holes in aluminum or titanium substructure.

c. Class 2G holes in graphite epoxy skin and class 2G holes in titanium substructure.

d. Class 2G holes in graphite epoxy skin and class 2G holes in aluminum and titanium substructure.

10. **REPAIR 46A.** See figure 8. Repair 46A is for:

- a. Class 2G holes in graphite epoxy bonded to titanium skin.
- b. Class 2G holes in graphite epoxy bonded to titanium skin and class 2G holes in aluminum or titanium substructure.
- c. Class 2G holes in graphite epoxy skin and class 2G holes in titanium substructure.
- d. Class 2G holes in graphite epoxy skin and class 2G holes in aluminum and titanium substructure.

11. **REPAIR 47.** See figure 9. Repair 47 is for class 2G holes in graphite epoxy skin and class 2G holes in inner wing - inboard aft spar flange:press fit bushing, and in aluminum and titanium substructure.

12. **REPAIR 47A.** See figure 10. Repair 47A is for class 2G holes in graphite epoxy skin and class 2G cold worked, holes in titanium substructure.

13. **REPAIR 47B.** See figure 11. Repair 47B is for class 2G holes in graphite epoxy skin and class 2G cold worked, holes in titanium substructure.

14. **REPAIR 48.** See figure 12. Repair 48 is for:

- a. Class 3 holes in graphite epoxy bonded to titanium skin.
- b. Class 3 holes in graphite epoxy bonded to titanium skin and class 3 holes in aluminum or titanium substructure.

c. Class 3 holes in graphite epoxy skin and class 3 holes in titanium substructure.

d. Class 3 holes in graphite epoxy skin and class 3 holes in aluminum and titanium substructure.

15. **REPAIR 49.** See figure 13. Repair 49 is for:

a. Jo-Bolt holes in graphite epoxy bonded to titanium skin on vertical stabilizer leading and trailing edges.

b. Jo-Bolt holes in graphite epoxy bonded to titanium skin, aluminum or titanium substructure, vertical stabilizer leading edge, and trailing edges.

c. Jo-Bolt holes in graphite epoxy skin and titanium substructure.

16. **REPAIR 50.** See figure 14. Repair 50 is for:

a. Rivet holes in graphite epoxy skin.

b. Rivet holes in graphite epoxy bonded to titanium skin.

c. Rivet holes in titanium structure.

REPAIR 41

HOLE COLOR CODE	GREEN	PINK	VIOLET
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.
POTTING			
BUSHING LINER RE374000002-1	-140	-141	1
LINER RE374000002-1	-104 PILOT 1 1 1	-142 PILOT 1 1 1	1
DRILLING			
DRILLING MACHINE	74D110314-1003 640-265 RPM POSITIVE FEED	74D110314-1003 640-265 RPM POSITIVE FEED	74D110314-1003 640-265 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	-221	-221	1
COOLANT BUSHING RE574000002-1	-AA	-AJ	1
DRILL TFIM25.0235	-234	-296	-359
REAMING INTERFERENCE HOLES IN SKIN AND SUBSTRUCTURE			
DRILLING MACHINE	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	-123	-123	1
COOLANT BUSHING RE574000002-1	-DS -DT -DU	-DV -DW -DX	1
REAMER TFIM25.121	-2455 -2611 -2767	-3093 -3236 -3392	-3705 -3861 -4017
REAMING CLASS 1 HOLES IN SKIN			
DRILLING MACHINE	250 RPM PISTOL GRIP	250 RPM PISTOL GRIP	250 RPM PISTOL GRIP
REAMER TFIM25.126	-2497 -2653 -2809	-3122 -3278 -3434	-3747 -3903 -4059

Figure 1. Close Tolerance Hole Fabrication, Repair 41 (Sheet 1)

REPAIR 41 (CONTINUED)

HOLE COLOR CODE	GREEN	PINK	VIOLET
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.
COUNTERSINKING SKIN			
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP
MICROSTOP CAGE	STANDARD	STANDARD	STANDARD
COUNTERSINK BODY TFIM25.0120	-247 -262 -278	-309 -324 -340	-367 -387 -403
CARBIDE INSERT TFIM25.0121	-492	-493	-493

LEGEND

1 NOT REQUIRED.

REPAIR 42

HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING				
BUSHING LINER RE374000002-1	-140	-141	1	1
STEP PIN RE374000002-1	-104 PILOT -105 -106 -107	-142 PILOT -143 -144 -145	1	1
DRILLING				
DRILLING MACHINE	74D110314-1003 640-265 RPM POSITIVE FEED	74D110314-1003 640-265 RPM POSITIVE FEED	74D110314-1003 640-265 RPM POSITIVE FEED	74D110314-1003 640-265 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	-221	-221	1	1
COOLANT BUSHING RE574000002-1	-AA	-AJ	1	1
DRILL TFIM25.0253	-234	-296	-359	-421
REAMING SKIN AND SUBSTRUCTURE				
DRILLING MACHINE	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	-123	-123	1	1
COOLANT BUSHING RE574000002-1	-AC -AE -AG	-AL -AN -AR	1	1
REAMER TFIM25.121	-2510 -2659 -2815	-3135 -3284 -3440	-3760 -3909 -4065	-4373 -4534 -4690
COUNTERSINKING SKIN				
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP
MICROSTOP CAGE RE574000002-1	STANDARD	STANDARD	STANDARD	STANDARD
COUNTERSINK BODY TFIM25.0120	-247 -262 -278	-309 -324 -340	-372 -387 -403	-434 -450 -465
CARBIDE INSERT TFIM25.0121	-492	-493	-493	-497

LEGEND

1 NOT REQUIRED.

Figure 2. Close Tolerance Hole Fabrication, Repair 42

REPAIR 43

HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING				
BUSHING LINER RE374000002-1	-140	-141	1	1
LINER RE374000002-1	-104 PILOT -105 -106 -107	-142 PILOT -143 -144 -145	1	1
DRILLING				
DRILLING MACHINE	74D110314-1003 640-265 RPM POSITIVE FEED	74D110314-1003 640-265 RPM POSITIVE FEED	74D110314-1003 640-265 RPM POSITIVE FEED	74D110314-1003 640-265 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	-221	-221	1	1
COOLANT BUSHING RE574000002-1	-AA	-AJ	1	1
DRILL TFIM25.0235	-234	-296	-359	-421
REAMING INTERFERENCE HOLES IN SKIN AND SUBSTRUCTURE				
DRILLING MACHINE	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	-123	-123	1	1
COOLANT BUSHING RE574000002-1	-DS -DT -DU	-DV -DW -DX	1	1
REAMER TFIM25.121	-2455 -2611 -2767	-3093 -3236 -3392	-3705 -3861 -4017	-4330 -4486 -4642
REAMING CLASS 2 HOLES IN SKIN				
DRILLING MACHINE	250 RPM PISTOL GRIP	250 RPM PISTOL GRIP	250 RPM PISTOL GRIP	250 RPM PISTOL GRIP
NOSE ADAPTER RE574000002-1	-123	-123	1	1
COOLANT BUSHING RE574000002-1	-AC -AE -AG	-AL -AN -AR	1	1
REAMER TFIM25.126	-2504 -2659 -2816	-3129 -3285 -3441	-3754 -3910 -4066	-4379 -4535 -4690

Figure 3. Close Tolerance Hole Fabrication, Repair 43 (Sheet 1)

REPAIR 43 (CONTINUED)

HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
FREE HAND COUNTERSINKING				
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP
MICROSTOP CAGE	STANDARD	STANDARD	STANDARD	STANDARD
COUNTERSINK CUTTERS				
COUNTERSINK BODY TFIM25.0120	-247 -262 -278	-309 -324 -340	-372 -387 -403	-434 -450 -465
CARBIDE INSERT TFIM25.0121	-492	-493	-493	-497

LEGEND

1 > NOT REQUIRED.

REPAIR 43A

HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING				
BUSHING LINER RE374000002-1	-198	-199	1	1
STEP PIN RE374000002-1	-104 PILOT -105 -106 -107	-104 PILOT -108 -109 -110	1 1 1	1 1 1
ADAPTER BUSHING RE374000002-1 2	-158	-158	1	1
DRILLING				
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110314-1003 640-265 RPM POSITIVE FEED	74D110314-1003 640-265 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	1	1
COOLANT BUSHING	-223	-220	1	1
DRILL TFIM25.0235	-234	-296	-359	-421
REAMING SKIN AND SUBSTRUCTURE				
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	1	1
COOLANT BUSHING RE574000002-1	-413 -424 -425	-426 -427 -428	1 1 1	1 1 1
REAMER TFIM25.121	-2455 -2611 -2767	-3093 -3236 -3392	-3705 -3861 -4017	-4330 -4486 -4642

Figure 4. Close Tolerance Hole Fabrication, Repair 43A (Sheet 1)

REPAIR 43A (CONTINUED)

HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
REAMING SKIN				
DRILLING MACHINE	250 RPM PISTOL GRIP	250 RPM PISTOL GRIP	250 RPM PISTOL GRIP	250 RPM PISTOL GRIP
REAMER TFIM25.126	-2504 -2659 -2816	-3129 -3285 -3441	-3754 -3910 -4066	-4379 -4535 -4690
COUNTERSINKING THROUGH DRILL PLATE 3				
DRILLING MACHINE	74D110312-1001 1000 RPM RACK FEED	74D110312-1001 1000 RPM RACK FEED	74D110312-1001 1000 RPM RACK FEED	74D110312-1001 1000 RPM RACK FEED
COUNTERSINK SUBASSEMBLY RE574000002-1	-BG	-BH	-B	-A
COUNTERSINKING SKIN				
COUNTERSINK BODY TFIM25.0120	-247 -262 -278	-309 -324 -340	-372 -387 -403	-434 -450 -465
CARBIDE INSERT TFIM25.0121	-492	-493	-493	-497

LEGEND

- 1 NOT REQUIRED.
- 2 ADAPTER BUSHING USED FOR POTTING BUSHING LINERS ONLY,
NOT USED WITH DRILLING MACHINES
- 3 SEE TABLE 1

TABLE 1. HOLES REQUIRING COUNTERSINKING THROUGH DRILL PLATE

SKIN P/N	HOLE NUMBERS
74A110600	235-250, 927-931, 933-978, AND 1001-1004
74A110601	174-189, 861-864, 951-1001, AND 1438-1441
74A150600	1-81 AND 195-204
74A150601	1-47, 58-76, 159-180, 383, 384, 437, AND 438

REPAIR 44

HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING				
BUSHING LINER RE374000002-1	1	-141	1	1
LINER RE374000002-1	1	-142	1	1
DRILLING				
DRILLING MACHINE	74D110314-1003 640-265 RPM POSITIVE FEED	74D110314-1003 640-265 RPM POSITIVE FEED	74D110314-1003 640-265 RPM POSITIVE FEED	74D110314-1003 640-265 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	-221	1	1
COOLANT BUSHING RE574000002-1	1	-AG	1	1
DRILL TFIM25.0235	-218	-281	-343	-406
REAMING PRE-COLD WORKED HOLES IN SKIN AND SUBSTRUCTURE 2				
DRILLING MACHINE	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	-ET -AL -EU	1	1
COOLANT BUSHING RE574000002-1	1	1	1	1
REAMER TFIM25.121	-2352 -2510 -2669	-2972 -3135 -3255	-3592 -3760 -3919	-4212 -4373 -4534
REAMING SKIN				
DRILLING MACHINE	250 RPM PISTOL GRIP	250 RPM PISTOL GRIP	250 RPM PISTOL GRIP	250 RPM PISTOL GRIP
REAMER TFIM25.126	-2503 -2659 -2815	-3128 -3284 -3440	-3753 -3909 -4065	-4378 -4534 -4689

Figure 5. Close Tolerance Hole Fabrication, Repair 44 (Sheet 1)

REPAIR 44 (CONTINUED)

HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
REAMING SUBSTRUCTURE AFTER COLD WORK				
DRILLING MACHINE	250 RPM PISTOL GRIP	250 RPM PISTOL GRIP	250 RPM PISTOL GRIP	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	1	1
COOLANT BUSHING RE574000002-1	1	1	1	1
REAMER TFIM25.116	-2497 -2653 -2809	-3122 -3278 -3434	-3747 -3903 -4059	TFIM25.111 -4372 -4528 -4684
COUNTERSINKING SKIN				
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP
NOSE ADAPTER RE574000002-1	1	1	1	1
MICROSTOP CAGE RE574000002-1	1	1	1	1
COUNTERSINK BODY TFIM25.0120	-247 -262 -278	-309 -324 -340	-372 -387 -403	-434 -450 -465
CARBIDE INSERT TFIM25.0121	-492	-493	-493	-497

LEGEND

1 NOT REQUIRED.

2 COLD WORK SUBSTRUCTURE USING RE174000002-1 FASTENER
HOLE COLD WORKING TOOL SET.

REPAIR 45

HOLE COLOR CODE	GREEN	PINK
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.
POTTING		
BUSHING LINER RE374000002-1	1	-141
STEP PIN RE374000002-1	1	-142
DRILLING		
DRILLING MACHINE	74D110314-1003 640-265 RPM POSITIVE FEED	74D110314-1003 640-265 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	-221
COOLANT BUSHING RE574000002-1	1	-AJ
DRILL TFIM25.0235	-234	-296
REAMING PRE-COLD WORKED HOLES IN SKIN AND SUBSTRUCTURE 2		
DRILLING MACHINE	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED
NOSE ADAPTER RE574000002-1	1	1
COOLANT BUSHING RE574000002-1	1	-DV -EU -EV
REAMER TFIM25.121	-2473 -2623 -2783	-3093 -3255 -3403

HOLE COLOR CODE	GREEN	PINK
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.
REAMING SKIN		
DRILLING MACHINE	500 RPM PISTOL GRIP	500 RPM PISTOL GRIP
REAMER TFIM25.126	-2504 -2659 -2815	-3129 -3285 -3441
COUNTERSINKING SKIN		
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP
NOSE ADAPTER RE574000002-1	1	1
COOLANT BUSHING RE574000002-1	1	1
MICROSTOP CAGE RE574000002-1	1	1
COUNTERSINK BODY TFIM25.0120	-247 -262 -278	-309 -324 -340
CARBIDE INSERT TFIM25.0121	-492	-493

LEGEND

1 NOT REQUIRED.

2 STRESS COIN SUBSTRUCTURE USING RE174000002-1 FASTENER
HOLE COLD WORKING TOOL SET.

Figure 6. Close Tolerance Hole Fabrication, Repair 45

REPAIR 46

HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING				
BUSHING LINER RE374000002-1	-140	-141	-101	-102
STEP PIN RE374000002-1	-104 PILOT -105 -106 -107	-142 PILOT -143 -144 -145	-111 PILOT -112 -113 -114	-115 PILOT -116 -117 -118
DRILLING				
DRILLING MACHINE	74D110314-1003 640-265 RPM POSITIVE FEED	74D110314-1003 640-265 RPM POSITIVE FEED	74D110314-1003 640-265 RPM POSITIVE FEED	74D110314-1003 640-265 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	-221	-221	-231	-231
COOLANT BUSHING RE574000002-1	-AA	-AJ	-C	-L
DRILL TFIM25.0235	-234	-296	-359	-421
REAMING SKIN AND SUBSTRUCTURE				
DRILLING MACHINE	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	-225	-225	-232	-232
COOLANT BUSHING RE574000002-1	-AC -AE -AG	-AL -AN -AR	-E -G -J	-N -R -T
REAMER TFIM25.121	-2510 -2659 -2815	-3135 -3284 -3440	-3760 -3909 -4065	-4385 -4534 -4690
FREE HAND COUNTERSINKING				
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP
MICROSTOP CAGE	STANDARD	STANDARD	STANDARD	STANDARD

Figure 7. Close Tolerance Hole Fabrication, Repair 46 (Sheet 1)

REPAIR 46 (CONTINUED)


HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
COUNTERSINK CUTTERS				
COUNTERSINK BODY TFIM25.0120	-247 -262 -278	-309 -324 -340	-372 -387 -403	-434 -450 -465
CARBIDE INSERT TFIM25.0121	-492	-493	-493	-497

REPAIR 46A

HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING				
BUSHING LINER RE374000002-1	-198	-103	-200	-201
STEP PIN RE374000002-1	-104 PILOT 1 1 1	-104 PILOT 1 1 1	-111 PILOT 1 1 1	-115 PILOT 1 1 1
ADAPTER BUSHING RE374000002-1 2	-158	-158	-159	-160
DRILLING				
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110314-1003 640-265 RPM POSITIVE FEED	74D110314-1003 640-265 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	-314	-231
COOLANT BUSHING RE574000002-1	-223	-220	-BR	-BL
DRILL TFIM25.0235	-234	-296	-359	-421
REAMING SKIN AND SUBSTRUCTURE				
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	-313	-232
COOLANT BUSHING RE574000002-1	-101 -102 -103	-104 -105 -106	-BS -BJ -BK	-BN -BM -BP
REAMER TFIM25.121	-2510 -2659 -2815	-3135 -3284 -3440	-3760 -3909 -4065	-4385 -4534 -4690

Figure 8. Close Tolerance Hole Fabrication, Repair 46A (Sheet 1)

REPAIR 46A (CONTINUED)

HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
COUNTERSINKING THROUGH DRILL PLATE 				
DRILLING MACHINE	74D110312-1001 1000 RPM RACK FEED	74D110312-1001 1000 RPM RACK FEED	74D110312-1001 1000 RPM RACK FEED	74D110312-1001 1000 RPM RACK FEED
COUNTERSINK SUBASSEMBLY RE574000002-1	-BG	-BH	-B	-A
COUNTERSINKING SKIN				
COUNTERSINK BODY TFIM25.0120	-247 -262 -278	-309 -324 -340	-372 -387 -403	-434 -450 -465
CARBIDE INSERT TFIM25.0121	-492	-493	-493	-497

LEGEND

-  NOT REQUIRED.
-  ADAPTER BUSHING USED FOR POTTING BUSHING LINERS ONLY, NOT USED WITH DRILLING MACHINES
-  SEE TABLE 1

TABLE 1. HOLES REQUIRING COUNTERSINKING THROUGH DRILL PLATE

SKIN P/N	HOLE NUMBERS
74A110600	235-250, 927-931, 933-978, AND 1001-1004
74A110601	174-189, 861-864, 951-1001, AND 1438-1441
74A150600	1-81 AND 195-204
74A150601	1-47, 58-76, 159-180, 383, 384, 437, AND 438

REPAIR 47

HOLE COLOR CODE	VIOLET
HOLE SIZE	3/8 FIRST OVS. SECOND OVS.
POTTING	
BUSHING LINER RE374000002-1	-102
STEP PIN RE374000002-1	-115 PILOT -197
DRILLING SKIN AND SUBSTRUCTURE	
DRILLING MACHINE	74D110314-1003 640-265 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	-231
COOLANT BUSHING RE574000002-1	-BB
DRILL TFIM25.0253	-359
DRILLING SUBSTRUCTURE	
DRILLING MACHINE	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	-232
COOLANT BUSHING RE574000002-1	-BC
DRILL SPT-74A110965	-5001
REAMING SUBSTRUCTURE, TWICE	
DRILLING MACHINE	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	-232
COOLANT BUSHING RE574000002-1	-BD
FIRST REAMER SPT2-74A110965	-5001
DRILLING MACHINE	150 RPM PISTOL GRIP
REAMER SPT2-74A110965	-5001
TRAVELER BUSHING RE574000002-1	-261

HOLE COLOR CODE	VIOLET
HOLE SIZE	3/8 FIRST OVS. SECOND OVS.
PRESS FIT BUSHING IN SUBSTRUCTURE REAMING SKIN AND SUBSTRUCTURE	
DRILLING MACHINE	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	-232
COOLANT BUSHING RE574000002-1 SHORT/LONG	-BE/-F
REAMER TFIM25.121	-3760
COUNTERSINKING SKIN	
DRILLING MACHINE	2000 RPM PISTOL GRIP
MICROSTOP CAGE	STANDARD
COUNTERSINK BODY TFIM25.0120	-372
CARBIDE INSERT TFIM25.0121	-493

Figure 9. Close Tolerance Hole Fabrication, Repair 47

REPAIR 47A.

HOLE COLOR CODE	PINK	VIOLET	YELLOW
HOLE SIZE	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING			
BUSHING LINER RE374000002-1	1	1	-102
STEP PIN RE374000002-1	1	1	-115
DRILLING			
DRILLING MACHINE	74D110314-1003 640-265 RPM POSITIVE FEED	74D110314-1003 640-265 RPM POSITIVE FEED	74D110314-1003 640-265 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	-231
COOLANT BUSHING RE574000002-1	1	1	-DH
DRILL TFIM25.0235	-281	-343	-406
REAMING SKIN AND SUBSTRUCTURE, PRE COLD WORKING 2			
DRILLING MACHINE	74D110313-1001 265 RPM HYDRAULIC FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	-232
COOLANT BUSHING RE574000002-1	1	1	-DP -DR -R
REAMER TFIM25.121	-2972 -3135 -3255	-3592 -3760 -3919	-4212 -4373 -4534
REAMING SKIN AND SUBSTRUCTURE			
DRILLING MACHINE	74D110313-1001 265 RPM HYDRAULIC FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	-232
COOLANT BUSHING	1	1	-N -R -T
REAMER TFIM25.121	-3135 -3284 -3440	-3760 -3909 -4065	-4385 -4534 -4690

Figure 10. Close Tolerance Hole Fabrication, Repair 47A (Sheet 1)

REPAIR 47A. (CONTINUED)

HOLE COLOR CODE	PINK	VIOLET	YELLOW
HOLE SIZE	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
FREE HAND COUNTERSINKING			
DRILLING MACHINE	2000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP
MICROSTOP CAGE	STANDARD	STANDARD	STANDARD
COUNTERSINK CUTTERS			
COUNTERSINK BODY TFIM25.0120	-309 -324 -340	-372 -387 -403	-434 -450 -465
CARBIDE INSERT TFIM25.0121	-493	-493	-497

LEGEND

1 NOT REQUIRED.

2 COLD WORK SUBSTRUCTURE USING RE174000002-1 FASTENER
HOLE COLD WORKING TOOL SET.


Figure 10. Close Tolerance Hole Fabrication, Repair 47A (Sheet 2)

REPAIR 47B

HOLE COLOR CODE	PINK	VIOLET	YELLOW
HOLE SIZE	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING			
BUSHING LINER RE374000002-1	-199	-200	-201
STEP PIN RE374000002-1	-104 PILOT 1 1 1	-111 PILOT 1 1 1	-115 PILOT 1 1 1
ADAPTER BUSHING RE374000002-1 2	-158	-159	-160
DRILLING			
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110314-1003 640-265 RPM POSITIVE FEED	74D110314-1003 640-265 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	-314	-314
COOLANT BUSHING RE574000002-1	-392	-DG	-DH
DRILL TFIM25.0235	-281	-343	-406
REAMING PRE-COLD WORKED HOLE IN SKIN AND SUBSTRUCTURE			
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	-313	-313
COOLANT BUSHING RE574000002-1	-393 -104 -394	-D -E -CV	-CX -CY -R
REAMER TFIM25.121	-2972 -3135 -3255	-3592 -3760 -3919	-4212 -4373 -4534

Figure 11. Close Tolerance Hole Fabrication, Repair 47B (Sheet 1)

REPAIR 47B (CONTINUED)

HOLE COLOR CODE	PINK	VIOLET	YELLOW
HOLE SIZE	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
REAMING CLASS 2G HOLES IN SKIN AND SUBSTRUCTURE			
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	-313	-313	-313
COOLANT BUSHING RE574000002-1	-104 -105 -106	-BS -BJ -BK	-N -R -T
REAMER TFIM25.121	-3135 -3284 -3440	-3760 -3909 -4065	-4385 -4534 -4690
COUNTERSINKING THROUGH DRILL PLATE 			
DRILLING MACHINE	74D110312-1001 1000 RPM RACK FEED	74D110312-1001 1000 RPM RACK FEED	74D110312-1001 1000 RPM RACK FEED
COUNTERSINK SUBASSEMBLY RE574000002-1	-BH	-B	-A
COUNTERSINKING SKIN			
COUNTERSINK BODY TFIM25.0120	-309 -324 -340	-372 -387 -403	-434 -450 -465
CARBIDE INSERT TFIM25.0121	-493	-493	-497

LEGEND

-  NOT REQUIRED.
-  ADAPTER BUSHING USED FOR POTTING BUSHING LINERS ONLY, NOT USED WITH DRILLING MACHINES
-  SEE TABLE 1

TABLE 1. HOLES REQUIRING COUNTERSINKING THROUGH DRILL PLATE

SKIN P/N	HOLE NUMBERS
74A110600	235-250, 927-931, 933-978, AND 1001-1004
74A110601	174-189, 861-864, 951-1001, AND 1438-1441
74A150600	1-81 AND 195-204
74A150601	1-47, 58-76, 159-180, 383, 384, 437, AND 438

REPAIR 48

HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING				
BUSHING LINER RE374000002-1	-140	-141	-101	-102
STEP PIN RE374000002-1	-104 PILOT -184 -106 -107	-142 PILOT -176 -144 -145	-111 PILOT -186 -113 -114	-115 PILOT -116 1 1
DRILLING				
DRILLING MACHINE	74D110314-1003 640-265 RPM POSITIVE FEED	74D110314-1003 640-265 RPM POSITIVE FEED	74D110314-1003 640-265 RPM POSITIVE FEED	74D110314-1003 640-265 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	-221	-221	-231	-231
COOLANT BUSHING RE574000002-1 SHORT/LONG	-AZ/-BU	-BA/-GF	-AY	-L/-M
DRILL TFIM25.0235	-252	-315	-377	-421
REAMING SKIN AND SUBSTRUCTURE				
DRILLING MACHINE	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	-123	-123	-232	-232
COOLANT BUSHING RE574000002-1 SHORT/LONG	1 -AE/-BV -AG/-BW	1 -AN/-BZ -AR/-CA	1 -G -J	-N/-P 1 1
REAMER TFIM25.121	1 -2659 -2815	1 -3284 -3440	1 -3909 -4065	-4385 1 1
COUNTERSINKING SKIN				
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP
MICROSTOP CAGE	STANDARD	STANDARD	STANDARD	STANDARD
COUNTERSINK BODY TFIM25.0120	-247 -262 -278	-309 -324 -340	-372 -387 -403	-434 1 1
CARBIDE INSERT TFIM25.0121	-492	-493	-493	-497

LEGEND

1 NOT REQUIRED.

Figure 12. Close Tolerance Hole Fabrication, Repair 48

REPAIR 49

HOLE COLOR CODE	SILVER	ORANGE	GREEN
HOLE SIZE	5/32 FIRST OVS. SECOND OVS.	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.
POTTING			
BUSHING LINER RE374000002-1	-140	-229	-140
STEP PIN RE374000002-1	-215	-183 PILOT -230 -231	-104 PILOT -217 -218 1
DRILLING			
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED
NOSE ADAPTER RE574000002-1	1	-485	-123
COOLANT BUSHING RE574000002-1 SHORT/LONG	-396	-FJ/-FA	-AZ/-AV
DRILL TFIM25.0253	-243	-191	-252
REAMING SKIN AND SUBSTRUCTURE			
DRILLING MACHINE	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED
NOSE ADAPTER RE574000002-1	1	-485	-123
COOLANT BUSHING RE574000002-1 SHORT/LONG	1	-FK/-FB -FL/-FC 1	-DT/-DZ -DU/-EA 1
REAMER TFIM25.121	-1650 -1808 1	-1998 -2158 1	-2608 -2767 1

Figure 13. Close Tolerance Hole Fabrication, Repair 49 (Sheet 1)

REPAIR 49 (CONTINUED)

HOLE COLOR CODE	SILVER	ORANGE	GREEN
HOLE SIZE	5/32 FIRST OVS. SECOND OVS.	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.
COUNTERSINKING SKIN			
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP
NOSE ADAPTER RE574000002-1	1	1	1
COOLANT BUSHING RE574000002-1	1	1	1
MICROSTOP CAGE	STANDARD	STANDARD	STANDARD
COUNTERSINK BODY TFIM25.0120	-161 -177 TBD	-196 -212 TBD	-257 -273 TBD
CARBIDE INSERT TFIM25.0121	-492	-492	-492

LEGEND

1 NOT REQUIRED.

Figure 13. Close Tolerance Hole Fabrication, Repair 49 (Sheet 2)

REPAIR 50

HOLE COLOR CODE	ORANGE
HOLE SIZE	3/16 FIRST OVS. SECOND OVS.
POTTING	
BUSHING LINER RE374000002-1	-229
STEP PIN RE374000002-1	-183 -232
DRILLING	
DRILLING MACHINE	74D110316-1001 265 RPM HYDRAULIC FEED
NOSE ADAPTER RE574000002-1	-485
COOLANT BUSHING RE574000002-1	-FJ/-FA
DRILL TFIM25.0235	-191
REAMING SKIN AND SUBSTRUCTURE	
DRILLING MACHINE	74D110313-1001 265 RPM HYDRAULIC FEED
NOSE ADAPTER RE574000002-1	-485
COOLANT BUSHING RE574000002-1 SHORT/LONG	-FM/-FD
REAMER TFIM25.121	-2120 1

REPAIR 50

HOLE COLOR CODE	ORANGE
HOLE SIZE	3/16 FIRST OVS. SECOND OVS.
COUNTERSINKING SKIN	
DRILLING MACHINE	2000 RPM PISTOL GRIP
MICROSTOP CAGE	STANDARD
COUNTERSINK BODY TFIM25.0120	-196
CARBIDE INSERT TFIM25.0121	-492
LEGEND	
1 NOT REQUIRED.	

Figure 14. Close Tolerance Hole Fabrication, Repair 50

DEPOT MAINTENANCE

STRUCTURE REPAIR

SHOP PRACTICES

CLOSE TOLERANCE HOLE FABRICATION, REPAIR NUMBERS 51 THRU 60A

Reference Material

Structure Repair, General Information	A1-F18AC-SRM-200
Fastener Hole Classification Data	WP004 15

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Record of Applicable Technical Directives

None

1. CLOSE TOLERANCE HOLE
FABRICATION.

2. This work package provides guidelines to depot personnel for correct selection of tools and equipment required for close tolerance hole fabrication. To make sure hole integrity is maintained, use of repair numbers is required. For fastener hole classification data, (WP004 15).

3. **REPAIR 51.** See figure 1. Repair 51 is for:

a. Class 1 holes in graphite epoxy skin.

b. Interference fit holes in aluminum or titanium substructure.

4. **REPAIR 52.** Data to be supplied when available.

5. **REPAIR 53.** Data to be supplied when available.

6. **REPAIR 54.** See figure 2. Repair 54 is for:

a. Drilling and reaming interference fit holes in titanium skin.

b. Drilling and reaming interference fit holes in titanium or aluminum structure.

7. **REPAIR 55.** See figure 3. Repair 55 is for:

a. Interference fit holes in titanium skin.

b. Interference fit holes in titanium skin and interference fit holes in aluminum or titanium substructure.

c. Interference fit holes in titanium substructure.

8. **REPAIR 55A.** See figure 4. Repair 55A is for:

a. Interference fit holes in titanium skin.

b. Interference fit holes in aluminum or titanium substructure.

9. **REPAIR 56.** See figure 5. Repair 56 is for:

a. Class 2 holes in titanium skin.

b. Class 2 holes in titanium skin and class 2 holes in aluminum or titanium substructure.

c. Class 2 holes in aluminum skin and class 2 holes in titanium substructure.

d. Class 2 holes in titanium substructure.

10. **REPAIR 57.** See figure 6. Repair 57 is for:

a. Class 2, cold worked, holes in titanium skin.

b. Class 2, cold worked, holes in titanium skin and class 2, cold worked, holes in aluminum or titanium substructure.

c. Class 2, cold worked, holes in aluminum skin and class 2, cold worked, holes in titanium substructure.

d. Class 2, cold worked, holes in titanium substructure.

11. **REPAIR 58.** See figure 7. Repair 58 is for class 2, stress coined, holes in titanium substructure.

12. **REPAIR 59.** See figure 8. Repair 59 is for:

a. Class 2G holes in titanium skin and class 2G holes in titanium substructure.

b. Class 2G holes in titanium substructure.

c. Class 2G holes in titanium skin.

13. **REPAIR 59A.** See figure 9. Repair 59A is for:

a. Class 2G holes in titanium skin and class 2G, cold worked, holes in titanium substructure.

b. Class 2G, cold worked, holes in titanium substructure.

14. **REPAIR 60.** See figure 10. Repair 60 is for:

a. Class 3 holes in titanium skin.

b. Class 3 holes in titanium skin and class 3 holes in aluminum or titanium substructure.

c. Class 3 holes in aluminum skin and class 3 holes in titanium substructure.

d. Class 3 holes in titanium substructure.

15. **REPAIR 60A.** See figure 11. Repair 60A is for class D holes in titanium substructure.

REPAIR 51.

HOLE COLOR CODE	PINK
HOLE SIZE	5/16 FIRST OVS. SECOND OVS.
POTTING	
BUSHING LINER RE374000002-1	TBD
STEP PIN RE374000002-1	TBD
DRILLING	
DRILLING MACHINE	74D110313-1001 265 RPM HYDRAULIC FEED
NOSE ADAPTER RE574000002-1	1
COOLANT BUSHING RE574000002-1	1
DRILL TFIM25.0235	-296
REAMING SKIN AND SUBSTRUCTURE	
DRILLING MACHINE	74D110313-1001 265 RPM HYDRAULIC FEED
NOSE ADAPTER RE574000002-1	TBD
COOLANT BUSHING RE574000002-1	TBD TBD TBD
REAMER TFIM25.121	-3093 -3236 -3392

Figure 1. Close Tolerance Hole Fabrication, Repair 51 (Sheet 1)

REPAIR 51 (CONTINUED)

HOLE COLOR CODE	PINK
HOLE SIZE	5/16 FIRST OVS. SECOND OVS.
REAMING SKIN	
DRILLING MACHINE	250 RPM PISTOL GRIP
NOSE ADAPTER RE574000002-1	1
COOLANT BUSHING RE574000002-1	1 1 1
REAMER TFIM25.126	-3122 -3278 -3434
COUNTERSINKING SKIN	
DRILLING MACHINE	2000 RPM PISTOL GRIP
MICROSTOP CAGE	STANDARD
COUNTERSINK BODY TFIM25.0120	-309 -324 -340
CARBIDE INSERT TFIM25.0121	-493 1 1

LEGEND

1 NOT REQUIRED

REPAIR 54

HOLE COLOR CODE	ORANGE	GREEN	PINK	VIOLET
HOLE SIZE	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.
POTTING				
BUSHING LINER RE374000002-1	-222	-223	-224	-225
STEP PIN RE374000002-1	-183 PILOT -226 -227 -228	-104 PILOT -216 -217 -218	-142 PILOT -219 -220 -221	-111 PILOT -149 -150 -151
ADAPTER BUSHING RE574000002-1	1	1	1	1
DRILLING (BUSHING LENGTH 1-1/8/1-3/8 3)				
DRILLING MACHINE	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED
NOSE ADAPTER RE574000002-1	-485	-123	-123	-484
COOLANT BUSHING RE574000002-1 SHORT/LONG	-EW/-FE	-AA/-AB	-AJ/-AK	-C/-D
DRILL TFIM25.0213	-038	-078	-108	-130
REAMING SKIN AND SUBSTRUCTURE (BUSHING LENGTH 1-1/8/1-3/8 3)				
DRILLING MACHINE	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED
NOSE ADAPTER RE574000002-1	-485	-123	-123	-484
COOLANT BUSHING RE574000002-1 SHORT/LONG	-EX/-FF -EY/-FG -EG/-FH	-DS/-DY -DT/-DZ -DU/-EA	-EH/-EB -DW/-EC -DX/-ED	-DL/-CM -DM/-CN -DN/-CP
REAMER TFIM25.111	-1852 -1983 -2139	-2452 -2608 -2764	-3077 -3233 -3389	-3702 -3858 -4014

Figure 2. Close Tolerance Hole Fabrication, Repair 54 (Sheet 1)

REPAIR 54 (CONTINUED)

HOLE COLOR CODE	ORANGE	GREEN	PINK	VIOLET
HOLE SIZE	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.
COUNTERSINKING				
DRILLING MACHINE	250 RPM PISTOL GRIP	250 RPM PISTOL GRIP	250 RPM PISTOL GRIP	250 RPM PISTOL GRIP
MICROSTOP CAGE	STANDARD	STANDARD	STANDARD	STANDARD
COUNTERSINK BODY TFIM25.014	-0904 -1914 -1144	-1344 -2574 -2734	-1584 -3194 -3364	-1934 -3874 -3984

LEGEND

- 1 NOT REQUIRED.
- 2 ADAPTER BUSHINGS USED FOR POTTING BUSHINGS ONLY,
NOT USED WITH DRILLING MACHINES.
- 3 SKIN THICKNESS REQUIRES LONGER OR SHORTER BUSHINGS.

REPAIR 55

HOLE COLOR CODE	ORANGE	GREEN	PINK	VIOLET
HOLE SIZE	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.
POTTING				
BUSHING LINER RE374000002-1	1	-140	-141	-101
STEP PIN RE374000002-1	1 1 1	-104 PILOT -216 -217 -218	-142 PILOT -219 -220 -221	-111 PILOT -149 -150 -151
DRILLING				
DRILLING MACHINE	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED	74D110314-1001 640-265 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	-123	-123	-231
COOLANT BUSHING RE574000002-1 SHORT/LONG	1	-AB	-AK/-BX	-D
DRILL TFIM25.0213	-038 1 1	-078 1 1	-108 1 1	-130 1 1
REAMING SUBSTRUCTURE				
DRILLING MACHINE	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	-123	-123	-232
COOLANT BUSHING RE574000002-1 SHORT/LONG	1 1 1	-DY -DZ -EA	-EB/-GG -EC/-CH -ED/-GJ	-CM -CN -CP
REAMER TFIM25.111	-1852 -1983 -2139	-2452 -2608 -2764	-3077 -3233 -3389	-3702 -3852 -4014

LEGEND

1 NOT REQUIRED.

Figure 3. Close Tolerance Hole Fabrication, Repair 55

REPAIR 55A.

HOLE COLOR CODE	ORANGE	GREEN	PINK	VIOLET
HOLE SIZE	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.
POTTING				
BUSHING LINER RE374000002-1	1	-140	-141	-200
STEP PIN RE374000002-1	1 1 1	-104 PILOT -216 -217 -218	-142 PILOT -219 -220 -221	-111 PILOT -149 -150 -151
ADAPTER BUSHING RE574000002-1	1	1	1	-159
DRILLING				
DRILLING MACHINE	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED	74D110314-1001 640-265 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	-123	-123	-314
COOLANT BUSHING RE574000002-1	1	-AA	-AJ	-BR
DRILL TFIM25.0213	-038	-078	-108	-130
REAMING SKIN AND SUBSTRUCTURE				
DRILLING MACHINE	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	-123	-123	-313
COOLANT BUSHING RE574000002-1	1 1 1	-DS -DT -DU	-EH -DW -DX	-EJ -EK -EL
REAMER TFIM25.111	-1852 -1983 -2139	-2452 -2608 -2764	-3077 -3233 -3389	-3702 -3848 -4014
COUNTERSINKING SKIN				
DRILLING MACHINE	250 RPM PISTOL GRIP	250 RPM PISTOL GRIP	250 RPM PISTOL GRIP	74D110312-1003 180 RPM RACK FEED
COUNTERSINK SUBASSEMBLY RE574000002-1	1	1	1	-B
MICROSTOP CAGE	STANDARD	STANDARD	STANDARD	1
COUNTERSINK BODY TFIM25.014	-0904 -1914 -1144	-1344 -2574 -2734	-1584 -3194 -3364	-1934 -3874 -3984

LEGEND

1 NOT REQUIRED.

2 ADAPTER BUSHINGS USED FOR POTTING BUSHINGS ONLY, NOT USED WITH DRILLING MACHINES.

Figure 4. Close Tolerance Hole Fabrication, Repair 55A

REPAIR 56.

HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING				
BUSHING LINER RE374000002-1	TBD	-141	-200	-201
STEP PIN RE374000002-1	TBD TBD TBD	-142 PILOT -143 -144 -145	-111 PILOT -112 -113 -114	-115 PILOT -116 -117 -118
ADAPTER BUSHING RE574000002-1	1	1	-159	-160
DRILLING				
DRILLING MACHINE	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED	74D110314-1003 640-265 RPM POSITIVE FEED	74D110314-1003 640-265 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	TBD	-123	-314	-314
COOLANT BUSHING RE574000002-1 SHORT/LONG	TBD	-AJ/-AK	-BR	-BL
DRILL TFIM25.0213	-078 1 1	-108 1 1	-130 1 1	-150 1 1
REAMING SKIN AND SUBSTRUCTURE				
DRILLING MACHINE	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	TBD	-123	-313	-313
COOLANT BUSHING RE574000002-1 SHORT/LONG	TBD TBD TBD	-EP/-ER -AN/-AP -AR/-AS	-EE -BJ -BK	-EF -BN -BP
REAMER TFIM25.111	-2497 -2653 -2809	-3122 -3278 -3434	-3747 -3903 -4059	-4372 -4528 -4684

Figure 5. Close Tolerance Hole Fabrication, Repair 56 (Sheet 1)

REPAIR 56 (CONTINUED)

HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
COUNTERSINKING SKIN				
DRILLING MACHINE	250 RPM PISTOL GRIP	250 RPM PISTOL GRIP	74D110312-1003 180 RPM RACK FEED	74D110312-1003 180 RPM RACK FEED
COUNTERSINK SUBASSEMBLY RE574000002-1	1	1	-B	-A
MICROSTOP CAGE	STANDARD	STANDARD	1	1
COUNTERSINK BODY TFIM25.014	-1354 -2624 -2784	-1594 -1634 -3404	-1944 -3874 -4024	-2244 -2254 -4654

LEGEND

1 NOT REQUIRED.

REPAIR 57

HOLE COLOR CODE	GREEN	PINK	VIOLET
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.
POTTING			
BUSHING LINER RE374000002-1	TBD	TBD	TBD
STEP PIN RE374000002-1	TBD TBD TBD	TBD TBD TBD	TBD TBD TBD
DRILLING			
DRILLING MACHINE	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED	74D110314-1003 640-265 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	TBD	TBD	TBD
COOLANT BUSHING RE374000002-1	TBD	TBD	TBD
DRILL TFIM25.0213	-070 1 1	-102 1 1	-124 1 1
REAMING SKIN AND SUBSTRUCTURE PRE-COLD WORKING <2>			
DRILLING MACHINE	250 RPM PISTOL GRIP	250 RPM PISTOL GRIP	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	TBD
COOLANT BUSHING RE574000002-1	1	1	TBD TBD TBD
REAMER TFIM25.	113-2510 113-2810 113-3120	113-3803 113-4115 113-4420	111-3592 111-3752 111-3919
REAMING CLASS 2 HOLES IN SKIN AND SUBSTRUCTURE			
DRILLING MACHINE	250 RPM PISTOL GRIP	250 RPM PISTOL GRIP	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	TBD
COOLANT BUSHING RE574000002-1	1 1 1	1 1 1	TBD TBD TBD
REAMER TFIM25.	116-2497 116-2653 116-2809	116-3122 116-3278 116-3434	111-3747 111-3903 111-4059

Figure 6. Close Tolerance Hole Fabrication, Repair 57 (Sheet 1)

REPAIR 57 (CONTINUED)


HOLE COLOR CODE	GREEN	PINK	VIOLET
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.
COUNTERSINKING ALUMINUM SKIN			
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP
MICROSTOP CAGE	STANDARD	STANDARD	STANDARD
COUNTERSINKING SKIN			
DRILLING MACHINE	250 RPM PISTOL GRIP	250 RPM PISTOL GRIP	74D110312-1003 180 RPM RACK FEED
NOSE ADAPTER RE574000002-1	1	1	-TBD
COOLANT BUSHING RE574000002-1	1	1	-TBD
MICROSTOP CAGE RE574000002-1	-TBD	-TBD	-TBD
COUNTERSINK CUTTER			
COUNTERSINK BODY TFIM25.014	-1354 -2624 -2784	-1594 -1634 -3404	-1944 -3874 -4024

LEGEND

1 NOT REQUIRED.

2 COLD WORK SKIN/SUBSTRUCTURE USING RE174000002-1 FASTENER
HOLE COLD WORKING TOOL SET.

REPAIR 58

HOLE COLOR CODE	GREEN	PINK
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.
POTTING		
BUSHING LINER RE374000002-1	TBD	-141
STEP PIN RE374000002-1	TBD TBD TBD	-142 PILOT TBD TBD TBD
DRILLING		
DRILLING MACHINE	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED
NOSE ADAPTER RE574000002-1	TBD	-123
COOLANT BUSHING RE574000002-1 SHORT/LONG	TBD	-AK/-BX
DRILL TFIM25.0213	-078	-108
REAMING PRE-STRESS COIN HOLES IN SUBSTRUCTURE 		
DRILLING MACHINE	250 RPM PISTOL GRIP	250 RPM PISTOL GRIP
REAMER TFIM25.130	-2471 TBD TBD	-3091 TBD TBD

LEGEND

 STRESS COIN SUBSTRUCTURE USING RE174000002-1
FASTENER HOLE COLD WORKING TOOL SET

Figure 7. Close Tolerance Hole Fabrication, Repair 58

REPAIR 59.

HOLE COLOR CODE	ORANGE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING					
BUSHING LINER RE374000002-1	1	-140	-141	-101	-102
STEP PIN RE374000002-1	1 1 1	-105 -106 -107	-143 -144 -145	-112 -113 -114	-116 -117 -118
DRILLING					
DRILLING MACHINE	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED	74D110314-1001 640-265 RPM POSITIVE FEED	74D110314-1001 640-265 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	-123	-123	-231	-231
COOLANT BUSHING RE574000002-1 SHORT/LONG	1	-AB	-AK/-BX	-D	-M
DRILL TFIM25.0213	-038 1 1	-078 1 1	-108 1 1	-130 1 1	-150 1 1
REAMING SKIN/SUBSTRUCTURE					
DRILLING MACHINE	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	-123	-123	-232	-232
COOLANT BUSHING RE574000002-1 SHORT/LONG	1 1 1	-AD -AF -AH	-AM/-BY -AP/-BE -AS/-CA	-F/-CC -H/-CD -K/-CE	-P/-CG -S/-CH -U/-CJ
REAMER TFIM25.121	-1910 -2034 -2190	-2510 -2659 -2815	-3135 -3284 -3440	-3760 -3909 -4065	-4385 -4534 -4690
COUNTERSINKING SKIN					
DRILLING MACHINE	150 RPM PISTOL GRIP	150 RPM PISTOL GRIP	150 RPM PISTOL GRIP	74D110312-1003 180 RPM RACK FEED	74D110312-1003 180 RPM RACK FEED
COUNTERSINK SUBASSEMBLY RE574000002-1	STANDARD	STANDARD	STANDARD	-B	-A
COUNTERSINK BODY TFIM25.014	-1874 -2014 -2114	-1354 -2624 -2784	-3094 -1634 -3404	-1944 -3874 -4024	-2244 -2254 -2264

LEGEND

1 NOT REQUIRED.

Figure 8. Close Tolerance Hole Fabrication, Repair 59

REPAIR 59A.










HOLE COLOR CODE	PINK	VIOLET	YELLOW
HOLE SIZE	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING			
BUSHING LINER RE374000002-1	-141	-101	-102
STEP PIN RE374000002-1	-143 -144 -145	-112 -113 -114	-116 -117 -118
DRILLING			
DRILLING MACHINE	74D110313-1001 265 RPM HYDRAULIC FEED	74D110314-1003 640-265 RPM POSITIVE FEED	74D110314-1003 640-265 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	-123	-231	-231
COOLANT BUSHING RE574000002-1 SHORT/LONG	-AH/-BW	-DG/-ES	-CW/-GK
DRILL TFIM25.0213	-102	-124	-146
REAMING SKIN AND SUBSTRUCTURE, PRE-COLD WORK 			
DRILLING MACHINE	250 RPM PISTOL GRIP	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1		-232	-232
COOLANT BUSHING RE574000002-1 SHORT/LONG	  	-D/-CB -CU/-DA -CV/-DB	-CX/-DC -CY/-DD -CZ/-DE
REAMER TFIM25.	113-3803 113-4115 113-4420	111-3592 111-3752 111-3919	111-4212 111-4372 111-4514
REAMING CLASS 2 HOLE IN SKIN AND SUBSTRUCTURE			
DRILLING MACHINE	250 RPM PISTOL GRIP	74D110314-1009 POSITIVE FEED	74D110314-1009 POSITIVE FEED
NOSE ADAPTER RE574000002-1		-232	-232
COOLANT BUSHING RE574000002-1 SHORT/LONG	  	-F/-CC -G/-CD -K/-CE	-P/-CG -S/-CH -U/-CJ
REAMER TFIM25.121	-3135 -3284 -3440	-3760 -3909 -4065	-4385 -4534 -4690

Figure 9. Close Tolerance Hole Fabrication, Repair 59A (Sheet 1)

REPAIR 59A (CONTINUED)

HOLE COLOR CODE	PINK	VIOLET	YELLOW
HOLE SIZE	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
COUNTERSINKING SKIN			
DRILLING MACHINE	250 RPM PISTOL GRIP	74D110312-1003 180 RPM RACK FEED	74D110312-1003 180 RPM RACK FEED
COUNTERSINK SUBASSEMBLY RE574000002-1	1	-B	-A
MICROSTOP CAGE	STANDARD	1	1
COUNTERSINK BODY TFIM25.014	-3094 -1634 -3404	-1944 -3874 -4024	-2244 -2254 -2264

LEGEND

1 NOT REQUIRED.

2 COLD WORK SUBSTRUCTURE USING RE174000002-1 FASTENER
HOLE COLD WORKING TOOL SET.

REPAIR 60







































HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING				
BUSHING LINER RE374000002-1	-140	-141	-200	-201
STEP PIN RE374000002-1	-104 PILOT -184 -106 -107	-142 PILOT -176 -144 -145	-111 PILOT -112 -113 -114	-115 PILOT -116 
ADAPTER BUSHING RE574000002-1 			-159	-160
DRILLING BUSHING LENGTH 1-1/8 INCHES 				
DRILLING MACHINE	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED	74D110314-1003 640-265 RPM POSITIVE FEED	74D110314-1003 640-265 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	-123	-123	-314	-314
COOLANT BUSHING RE574000002-1 SHORT/MED/LONG	-AZ/-AV	-BA/-AW/-GF	-EG	-BL
DRILL TFIM25.0235	-252	-315	-377	-421
REAMING SKIN AND SUBSTRUCTURE BUSHING LENGTH 1-1/8 INCHES 				
DRILLING MACHINE	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	-123	-123	-313	-313
COOLANT BUSHING RE574000002-1 SHORT/MED/LONG	 -AE/-AF -AG/-AH	 -AN/-AP/-BE -AR/-AS/-CA	 -BJ -BK	-BM 
REAMER TFIM25.121	 -2659 -2815	 -3284 -3440	 -3909 -4065	-4385 

Figure 10. Close Tolerance Hole Fabrication, Repair 60 (Sheet 1)

REPAIR 60 (CONTINUED)

HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
DRILLING BUSHING LENGTH 1-3/8 INCHES 				
DRILLING MACHINE	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED	74D110314-1003 640-265 RPM POSITIVE FEED	74D110314-1003 640-265 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	-123	-123	-314	-314
COOLANT BUSHING RE574000002-1	-AZ	-BA	-EG	-BL
DRILL TFIM25.0235	-252  	-315  	-377  	-421  
REAMING SKIN AND SUBSTRUCTURE BUSHING LENGTH 1-3/8 INCHES 				
DRILLING MACHINE	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	-123	-123	-313	-313
COOLANT BUSHING RE574000002-1	 -AE -AG	 -AN -AR	 -BJ -BK	-BM  
REAMER TFIM25.121	 -2659 -2815	 -3284 -3440	 -3909 -4065	-4385  
COUNTERSINKING SKIN				
DRILLING MACHINE	250 RPM PISTOL GRIP	250 RPM PISTOL GRIP	74D110312-1003 180 RPM RACK FEED	74D110312-1003 180 RPM RACK FEED
COUNTERSINK SUBASSEMBLY RE574000002-1			-B	-A
COUNTERSINK BODY TFIM25.014	-1354 -2624 -2784	-3094 -1634 -3404	-1944 -3874 -4024	-2244  

LEGEND




-  NOT REQUIRED.
-  ADAPTER BUSHINGS USED FOR POTTING BUSHINGS ONLY, NOT USED WITH DRILLING MACHINES.
-  SKIN THICKNESS REQUIRES LONGER OR SHORTER BUSHINGS.

Figure 10. Close Tolerance Hole Fabrication, Repair 60 (Sheet 2)

REPAIR 60A.

HOLE COLOR CODE	ORANGE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING					
BUSHING LINER RE374000002-1	TBD	-103	-141	-101	-102
STEP PIN RE374000002-1	TBD TBD TBD	-122 TBD TBD	-177 TBD TBD	-112 TBD TBD	-125 TBD TBD
DRILLING					
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110313-1001 265 RPM HYDRAULIC FEED	74D110314-1003 640-265 RPM POSITIVE FEED	74D110314-1003 640-265 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	-123	-231	-231
COOLANT BUSHING RE574000002-1	TBD 1 1	-224 1 1	-AT 1 1	-AV 1 1	-S 1 1
DRILL TFIM25.0213	-054 1 1	-088 1 1	-116 1 1	-138 1 1	-154 1 1

LEGEND

1 NOT REQUIRED.

Figure 11. Close Tolerance Hole Fabrication, Repair 60A

DEPOT MAINTENANCE

STRUCTURE REPAIR

SHOP PRACTICES

CLOSE TOLERANCE HOLE FABRICATION, REPAIR NUMBERS 61 THRU 70

Reference Material

Structure Repair, General Information	A1-F18AC-SRM-200
Fastener Hole Classification Data	WP004 15

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Record of Applicable Technical Directives

None

1. CLOSE TOLERANCE HOLE FABRICATION.

2. This work package provides guidelines to depot personnel for correct selection of tools and equipment required for close tolerance hole fabrication. To make sure hole integrity is maintained, use of repair numbers is required. For fastener hole classification data, (WP004 15).

3. **REPAIR 61.** See figure 1. Repair 61 is used for:

a. Drilling and reaming special holes in titanium or aluminum skin.

b. Drilling and reaming special holes in titanium or aluminum skin and structure.

4. **REPAIR 62.** See figure 2. Repair 62 is for rivet holes in titanium substructure.

5. **REPAIR 63.** See figure 3. Repair 63 is for:

a. Close tolerance holes in titanium skin of vertical stabilizer/fuselage interface.

b. Close tolerance holes in titanium skin and close tolerance holes in aluminum substructure of vertical stabilizer/fuselage interface.

6. **REPAIR 64.** See figure 4. Repair 64 is for:

a. Interference fit holes in titanium skin.

b. Interference fit holes in titanium or aluminum substructure.

c. Both a. and b. above are for holes mating with 74A110957 inner wing inboard flap hinge or holes in 74A110855 skin.

7. **REPAIR 65.** Data to be supplied when available.

8. **REPAIR 66.** Data to be supplied when available.

9. **REPAIR 67.** Data to be supplied when available.

10. **REPAIR 68.** Data to be supplied when available.

11. **REPAIR 69.** Data to be supplied when available.

12. **REPAIR 70.** Data to be supplied when available.

REPAIR 61






HOLE COLOR CODE	BLUE	SILVER	ORANGE	GREEN
HOLE SIZE	1/8 FIRST OVS. SECOND OVS.	5/32 FIRST OVS. SECOND OVS.	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.
POTTING				
BUSHING LINER RE374000002-1	TBD	-140	-140	1
STEP PINS RE374000002-1	TBD TBD TBD	-187 1 1	-182 1 1	1 1 1
DRILLING				
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	1
NOSE ADAPTER RE574000002-1	1	1	1	1
COOLANT BUSHING	1	-234	-398	1
DRILL TFIM25,0235	1	-161	-191	1

LEGEND

1 NOT REQUIRED

Figure 1. Close Tolerance Hole Fabrication, Repair 61.

REPAIR 62

HOLE COLOR CODE	BLUE	SILVER	ORANGE	GREEN
HOLE SIZE	1/8 FIRST OVS. SECOND OVS.	5/32 FIRST OVS. SECOND OVS.	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.
POTTING				
BUSHING LINER RE374000002-1	TBD	-179	TBD	TBD
STEP PIN RE374000002-1	TBD TBD TBD	-187  	TBD TBD TBD	TBD TBD TBD
DRILLING				
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110313-1001 265 RPM HYDRO CHECK FEED
NOSE ADAPTER RE574000002-1				TBD
COOLANT BUSHING	TBD	-234	TBD	TBD
DRILL TFIM25.0213	-004	-028	-054	-088

LEGEND

 NOT REQUIRED.

Figure 2. Close Tolerance Hole Fabrication, Repair 62

REPAIR 63

HOLE COLOR CODE	VIOLET	YELLOW	BLACK
HOLE SIZE	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.	1/2 FIRST OVS. SECOND OVS.
POTTING			
BUSHING LINER RE374000002-1	-202	-203	-203
STEP PIN RE374000002-1	-239 PILOT -233 -234 -235	-265 PILOT -236 -237 -238	-265 PILOT -266 -267 -268
ADAPTER BUSHING RE374000002-1	-159	-160	-160
DRILLING			
DRILLING MACHINE	74D110314-1003 640-265 RPM POSITIVE FEED	74D110314-1003 640-265 RPM POSITIVE FEED	74D110314-1003 640-265 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	-314	-314	-314
COOLANT BUSHING RE574000002-1 SHORT/LONG	-FN/-FT	-FX/-GB	GS/GW
DRILL TFIM25	.0235-359 1 1	.0235-421 1 1	.0213-158 1 1
REAMING SKIN AND SUBSTRUCTURE			
DRILLING MACHINE	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	-313	-313	-313
COOLANT BUSHING RE574000002-1 SHORT/LONG	-FP/-FU -FR/-FV -FS/-FW	FY/GC FZ/GD GA/GE	GT/GX GU/GY OV/GZ
REAMER TFIM25	.121-3705 .121-3861 .121-4040	.121-4330 .121-4486 .121-4642	.111-4985 .111-5153 .111-5309
COUNTERSINKING SKIN			
DRILLING MACHINE	74D110312-1003 180 RPM RACK FEED	74D110312-1003 180 RPM RACK FEED	74D110312-1003 180 RPM RACK FEED
COUNTERSINK SUBASSEMBLY RE574000002-1	-CK	-CL	-CL
COUNTERSINK TFIM25.014	-3674 -1964 -4024	-4294 -4454 -4604	-2274 TBD TBD

LEGEND

1 NOT REQUIRED

Figure 3. Close Tolerance Hole Fabrication, Repair 63

REPAIR 64

HOLE COLOR CODE	GREEN	PINK	VIOLET
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.
POTTING			
BUSHING LINER RE374000002-1	TBD	TBD	TBD
STEP PIN RE374000002-1	TBD TBD TBD	TBD TBD TBD	TBD TBD TBD
DRILLING			
DRILLING MACHINE	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED
NOSE ADAPTER RE574000002-1	TBD	TBD	TBD
BUSHING LINER RE574000002-1	TBD	TBD	TBD
DRILL TFIM25.0213	-078	-108	-130
REAMING SKIN AND SUBSTRUCTURE			
DRILLING MACHINE	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED	74D110313-1001 265 RPM HYDRAULIC FEED
NOSE ADAPTER RE574000002-1	TBD	TBD	TBD
COOLANT BUSHING RE574000002-1	TBD TBD TBD	TBD TBD TBD	TBD TBD TBD
REAMER TFIM25.111	-2452 -2608 -2764	-3077 -3233 -3389	-3702 -3858 -4014
COUNTERSINKING SKIN			
DRILLING MACHINE	250 RPM PISTOL GRIP	250 RPM PISTOL GRIP	250 RPM PISTOL GRIP
NOSE ADAPTER RE574000002-1	STANDARD	STANDARD	STANDARD
COOLANT BUSHING RE574000002-1	1	1	1
MICROSTOP CAGE	1	1	1
COUNTERSINK BODY TFIM25.014	-1344 -2574 -2734	-1584 -3194 -3364	-1934 -3874 -3984

LEGEND

1 NOT REQUIRED.

Figure 4. Close Tolerance Hole Fabrication, Repair 64

DEPOT MAINTENANCE

STRUCTURE REPAIR

SHOP PRACTICES

CLOSE TOLERANCE HOLE FABRICATION, REPAIR NUMBERS 71 THRU 80

Reference Material

Structure Repair, General Information	A1-F18AC-SRM-200
Fastener Hole Classification Data	WP004 15

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Record of Applicable Technical Directives

None

1. CLOSE TOLERANCE HOLE
FABRICATION.

2. This work package provides guidelines to depot personnel for correct selection of tools and equipment required for close tolerance hole fabrication. To make sure hole integrity is maintained, use of repair numbers is required. For fastener hole classification data, (WP004 15).

3. **REPAIR 71.** Data to be supplied when available.

4. **REPAIR 72.** Data to be supplied when available.

5. **REPAIR 73.** Data to be supplied when available.

6. **REPAIR 74.** Data to be supplied when available.

7. **REPAIR 75.** See figure 1. Repair 75 is for:

a. Interference fit holes in aluminum skin.

b. Interference fit holes in aluminum skin and interference fit holes in aluminum substructure.

- c. Interference fit holes in aluminum substructure.
8. **REPAIR 75A.** See figure 2. Repair 75A is for:
- a. Interference fit holes in aluminum skin.
 - b. Interference fit holes in aluminum skin and interference fit holes in aluminum substructure.
9. **REPAIR 76.** See figure 3. Repair 76 is for:
- a. Interference fit holes, cold worked, in aluminum skin.
 - b. Interference fit holes, cold worked, in aluminum skin and interference fit holes, cold worked, in aluminum substructure.
 - c. Interference fit holes, cold worked, in aluminum substructure.
10. **REPAIR 77.** See figure 4. Repair 77 is for class 1 holes in aluminum substructure.
11. **REPAIR 78.** See figure 5. Repair 78 is for:
- a. Class 2 holes in aluminum skin.
 - b. Class 2 holes in aluminum skin and class 2 holes in aluminum substructure.

- c. Class 2 holes in aluminum substructure.
12. **REPAIR 78A.** See figure 6. Repair 78A is for:
- a. Class 2 holes in aluminum skin.
 - b. Class 2 holes in aluminum skin and class 2 holes in aluminum substructure.
13. **REPAIR 79.** See figure 7. Repair 79 is for:
- a. Class 2 holes, cold worked, in aluminum skin.
 - b. Class 2 holes, cold worked, in aluminum skin and class 2 holes, cold worked, in aluminum substructure.
 - c. Class 2 holes, cold worked, in aluminum substructure.
14. **REPAIR 79A.** See figure 8. Repair 79A is for:
- a. Class 2 holes, cold worked, in aluminum skin and class 2 holes, cold worked, in aluminum substructure.
 - b. Class 2 holes, cold worked, in aluminum substructure.
15. **REPAIR 80.** See figure 9. Repair 80 is for class 2 holes, stress coined, in aluminum substructure. 2 holes, stress coined, in aluminum substructure.

REPAIR 75.

HOLE COLOR CODE	SILVER	ORANGE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	5/32 FIRST OVS. SECOND OVS.	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING						
BUSHING LINER RE374000002-1	-179	-179	-179	-103	-101	TBD
STEP PIN RE374000002-1	-104 PILOT -187 1 1	-104 PILOT -189 -190 -191	-104 PILOT -192 -193 -194	-104 PILOT -146 -147 -148	-111 PILOT -149 -150 -151	TBD TBD TBD TBD
DRILLING						
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110314-1001 1100-450 RPM POSITIVE FEED	74D110314-1001 1100-450 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	1	1	-231	TBD
COOLANT BUSHING RE574000002-1 SHORT/LONG	-234	-235	-223	-220	-CB/-D	TBD
DRILL TFIM25.0204	-098	-108	-148	-178	-200	-220
REAMING SKIN AND SUBSTRUCTURE						
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	1	1	-232	TBD
COOLANT BUSHING RE574000002-1 SHORT/LONG	1 1 1	-236 -237 -238	-253 -254 -255	-386 -287 -388	-CR/-CM -CS/-CN -CT/-CP	TBD TBD TBD
REAMER TFIM25.111	1 TBD TBD	-1852 -1983 -2139	-2452 -2608 -2764	-3077 -3233 -3389	-3702 -3852 -4014	-4330 -4486 -4642
COUNTERSINKING SKIN						
DRILLING MACHINE	3000 RPM PISTOL GRIP	3000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP
MICROSTOP CAGE	STANDARD	STANDARD	STANDARD	STANDARD	STANDARD	STANDARD
COUNTERSINK TFIM25.014	-0824 1 1	-0904 -1914 -1144	-1344 -2574 -2734	-1584 -3194 -3364	-1934 -3824 -3984	TBD TBD TBD

LEGEND

1 NOT REQUIRED.

Figure 1. Close Tolerance Hole Fabrication, Repair 75

REPAIR 75A 2

HOLE COLOR CODE	SILVER	ORANGE	GREEN	PINK	VIOLET
HOLE SIZE	5/32 FIRST OVS. SECOND OVS.	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.
POTTING					
BUSHING LINER RE374000002-1	-182	1	-182	1	1
STEP PIN RE374000002-1	-195 1 1	1 1 1	-196 1 1	1 1 1	1 1 1
DRILLING					
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP
NOSE ADAPTER RE574000002-1	1	1	1	1	1
TRAVELER BUSHING RE574000002-1	-241 1 1	1 1 1	-242 1 1	1 1 1	1 1 1
DRILL TFIM25.0204	-098 1 1	-108 1 1	-148 1 1	-178 1 1	-200 1 1
REAMING SKIN AND SUBSTRUCTURE					
DRILLING MACHINE	1000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP	500 RPM PISTOL GRIP	500 RPM PISTOL GRIP
NOSE ADAPTER RE574000002-1	1	1	1	1	1
COOLANT BUSHING RE574000002-1	1 1 1	1 1 1	-243 TBD TBD	1 1 1	1 1 1
REAMER TFIM25.111	1 1 1	-1852 -1983 -2139	-2452 -2606 -2764	-3077 -3233 -3389	-3702 -3858 -4014
COUNTERSINKING SKIN					
DRILLING MACHINE	3000 RPM PISTOL GRIP	3000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP
MICROSTOP CAGE	STANDARD	STANDARD	STANDARD	STANDARD	STANDARD
COUNTERSINK BODY TFIM25.014	-0824 1 1	-0904 -1914 -1144	-1344 -2574 -2734	-1584 -3194 -3364	-1934 -3824 -3984

LEGEND

1 NOT REQUIRED.

2 THIS REPAIR NUMBER IS FOR LIMITED ACCESS HOLES AROUND AILERON HINGE ON 74A150824 SKIN.

Figure 2. Close Tolerance Hole Fabrication, Repair 75A

REPAIR 76

HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING				
BUSHING LINER RE374000002-1	-103	-103	-101	-102
STEP PIN RE374000002-1	-104 PILOT -105 -106 -107	-104 PILOT -108 -109 -110	-111 PILOT -112 -113 -114	-115 PILOT -116 -117 -118
DRILLING				
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	74D110314-1009 1100-450 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	1	TBD
COOLANT BUSHING RE374000002-1	TBD	TBD	TBD	TBD
DRILL TFIM25.0204	-140	-172	-194	-216
REAMING SKIN AND SUBSTRUCTURE PRE-COLD WORKING 2				
DRILLING MACHINE	1000 RPM PISTOL GRIP	500 RPM PISTOL GRIP	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	TBD	TBD
COOLANT BUSHING RE574000002-1	1	1	TBD TBD TBD	TBD TBD TBD
REAMER TFIM25.	113-2510 113-2810 113-3120	113-3803 113-4115 113-4420	111-3592 111-3752 111-3919	111-4212 111-4372 111-4514
REAMING INTERFERENCE HOLES IN SKIN AND SUBSTRUCTURE				
DRILLING MACHINE	1000 RPM PISTOL GRIP	500 RPM PISTOL GRIP	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	TBD	TBD
COOLANT BUSHING RE574000002-1	TBD TBD TBD	TBD TBD TBD	TBD TBD TBD	TBD TBD TBD
REAMER TFIM25.121	-2455 -2611 -2767	-3093 -3236 -3392	-3705 -3861 -4017	-4330 -4486 -4642

Figure 3. Close Tolerance Hole Fabrication, Repair 76 (Sheet 1)

REPAIR 76 (CONTINUED)

HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
COUNTERSINKING SKIN				
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP	TBD
NOSE ADAPTER RE574000002-1	1	1	1	TBD
COOLANT BUSHING RE574000002-1	1	1	1	TBD
MICROSTOP CAGE	STANDARD	STANDARD	STANDARD	STANDARD
COUNTERSINK TFIM25.014	-1344 -2574 -2734	-1584 -3194 -3364	-1934 -3824 -3984	-TBD -TBD -TBD

LEGEND

- 1 NOT REQUIRED.
- 2 COLD WORK SKIN/SUBSTRUCTURE USING RE174000002-1 FASTENER
HOLE COLD WORKING TOOL SET.

REPAIR 76











HOLE COLOR CODE	GREEN	PINK	VIOLET
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.
POTTING			
BUSHING LINER RE374000002-1	-103	-103	-101
STEP PIN RE374000002-1	-104 PILOT -105 -106 -107	-104 PILOT -108 -109 -110	-111 PILOT -112 -113 -114
DRILLING			
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110314-1001 1100-450 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	1
COOLANT BUSHING RE374000002-1	TBD	TBD	TBD
DRILL TFIM25.0204	-148	-178	-200
REAMING SUBSTRUCTURE			
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	TBD
COOLANT BUSHING RE374000002-1	TBD TBD TBD	TBD TBD TBD	TBD TBD TBD
REAMER TFIM25.111	-2497 -2653 -2809	-3122 -3278 -3434	-3747 -3903 -4059

LEGEND

1 NOT REQUIRED.

Figure 4. Close Tolerance Hole Fabrication, Repair 77

REPAIR 78.

HOLE COLOR CODE	SILVER	ORANGE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	5/32 FIRST OVS. SECOND OVS.	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING						
BUSHING LINER RE374000002-1	-179	-179	-103	-103	-101	-102
STEP PIN RE374000002-1	-104 PILOT -215 	-104 PILOT -182 -204 -205	-104 PILOT -105 -106 -107	-104 PILOT -108 -109 -110	-111 PILOT -112 -113 -114	-115 PILOT -116 -117 -118
DRILLING						
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110314-1001 1100-450 RPM POSITIVE FEED	74D110314-1001 1100-450 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1					-231	-231
COOLANT BUSHING RE574000002-1 SHORT/LONG	-449	-235	-223	-220	-D/-CB	-M/-CF
DRILL TFIM25.0204	-084	-108	-148	-178	-200	-220
REAMING SKIN AND SUBSTRUCTURE						
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1					-232	-232
COOLANT BUSHING RE574000002-1 SHORT/LONG	-450 	-411 -412 -389	-414 -415 -392	-417 -418 -419	-CU/-DA -H/-CD -K/-CE	-CY/-DD -S/-CH -U/-CJ
REAMER TFIM25.	116-1637	116-1897 116-2028 116-2184	116-2497 116-2653 116-2809	116-3122 116-3278 116-3434	111-3747 111-3903 111-4059	111-4372 111-4528 111-4684
COUNTERSINKING SKIN						
DRILLING MACHINE	3000 RPM PISTOL GRIP	3000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP
MICROSTOP CAGE	STANDARD	STANDARD	STANDARD	STANDARD	STANDARD	STANDARD
COUNTERSINK TFIM25.014	-1604	-1894 -2014 -2114	-1354 -2624 -2784	-1594 -1634 -3404	-1944 -3874 -4024	-2244 -2254 -4654

LEGEND

 NOT REQUIRED.

Figure 5. Close Tolerance Hole Fabrication, Repair 78

REPAIR 78A.

HOLE COLOR CODE	GREEN	PINK
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.
POTTING		
BUSHING LINER RE374000002-1	-103	-103
STEP PIN RE374000002-1	-251 -252 -253	-254 -255 -256
DRILLING		
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP
NOSE ADAPTER RE574000002-1	1	1
COOLANT BUSHING RE374000002-1	TBD	TBD
DRILL TFIM25.0204	-148	-178
REAMING HINGE		
DRILLING MACHINE	1000 RPM PISTOL GRIP	500 RPM PISTOL GRIP
REAMER TFIM25.116	-2497 -2653 -2809	-3122 -3278 -3434
COUNTERSINKING HINGE		
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP
NOSE ADAPTER RE574000002-1	1	1
COOLANT BUSHING RE574000002-1	1	1
MICROSTOP CAGE	STANDARD	STANDARD
COUNTERSINK TFIM25.014	-1354 -2624 -2784	-1594 -1634 -3404

LEGEND

1 NOT REQUIRED.

Figure 6. Close Tolerance Hole Fabrication, Repair 78A

REPAIR 79

HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING				
BUSHING LINER RE374000002-1	-103	-103	-101	-102
STEP PIN RE374000002-1	-104 PILOT -105 -106 -107	-104 PILOT -108 -109 -110	-111 PILOT -112 -113 -114	-115 PILOT -116 -117 -118
DRILLING				
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110314-1001 1100-450 RPM POSITIVE FEED	74D110314-1001 1100-450 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	-231	-231
COOLANT BUSHING RE574000002-1 SHORT/LONG	-389	-392	-DG/-ES	-CW/-GK
DRILL TFIM25.0204	-140	-172	-194	-216
REAMING SKIN AND SUBSTRUCTURE, PRE-COLD WORKING 2				
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	-232	-232
COOLANT BUSHING 2 RE574000002-1 SHORT/LONG	-390 -101 -463	-393 -104 -464	-D/-CB -CU/-DA -CV/-DB	-CX/-DC -CY/-DD -CZ/-DE
REAMER TFIM25.111	-2352 -2512 -2669	-2972 -3133 -3295	-3592 -3752 -3919	-4212 -4372 -4514
REAMING CLASS 2 HOLES IN SKIN AND SUBSTRUCTURE				
DRILLING MACHINE	1000 RPM PISTOL GRIP	500 RPM PISTOL GRIP	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	-232	-232
COOLANT BUSHING RE574000002-1 SHORT/LONG	1 1 1	1 1 1	-CU/-DA -H/-CD -K/-CE	-CY/-DD -S/-CH -U/-CJ
REAMER TFIM25.	116-2497 116-2653 116-2809	116-3122 116-3278 116-3434	111-3747 111-3903 111-4059	111-4372 111-4528 111-4684

Figure 7. Close Tolerance Hole Fabrication, Repair 79 (Sheet 1)

REPAIR 79 (CONTINUED)

HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
COUNTERSINKING SKIN <2>				
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP
MICROSTOP CAGE	STANDARD	STANDARD	STANDARD	STANDARD
COUNTERSINK TFIM25.014	-1354 -2624 -2784	-1594 -1634 -3404	-1944 -3874 -4024	-2244 -2254 -4654

LEGEND

- 1> NOT REQUIRED.
- 2> COLD WORK SKIN/SUBSTRUCTURE USING RE174000002-1 FASTENER
HOLE COLD WORKING TOOL SET.

Figure 7. Close Tolerance Hole Fabrication, Repair 79 (Sheet 2)

REPAIR 79A

HOLE COLOR CODE	PINK	VIOLET	YELLOW
HOLE SIZE	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING			
BUSHING LINER RE374000002-1	TBD	TBD	TBD
STEP PIN RE374000002-1	TBD TBD TBD	TBD TBD TBD	TBD TBD TBD
DRILLING			
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP
NOSE ADAPTER RE574000002-1	1	1	1
COOLANT BUSHING RE574000002-1	1	1	1
DRILL TFIM25.0204	-172	-194	-220
REAMING PRE-COLD WORKED HOLES IN HINGE			
DRILLING MACHINE	500 RPM PISTOL GRIP	250 RPM PISTOL GRIP	250 RPM PISTOL GRIP
REAMER TFIM25.	113-3803 113-4115 113-4420	113-4980 113-5405 113-5710	1 116-4372 1
REAMING CLASS 1 HOLES IN SKIN			
DRILLING MACHINE	500 RPM PISTOL GRIP	250 RPM PISTOL GRIP	250 RPM PISTOL GRIP
REAMER TFIM25.	116-3122 116-3278 116-3434	116-3747 116-3903 116-4059	126-4378 126-4534 126-2689
COUNTERSINKING HINGE			
DRILLING MACHINE	2000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP
NOSE ADAPTER RE574000002-1	1	1	1
COOLANT BUSHING RE574000002-1	1	1	1
MICROSTOP CAGE TFIM25.014	-1594 -1634 -3404	-1944 -3874 -4024	-2244 -2254 -4654

LEGEND

1 NOT REQUIRED.

Figure 8. Close Tolerance Hole Fabrication, Repair 79A

REPAIR 80

HOLE COLOR CODE	GREEN	PINK
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.
POTTING		
BUSHING LINER RE374000002-1	-103	-103
STEP PIN RE374000002-1	-104 PILOT -105 -106 -107	-104 PILOT -108 -109 -110
DRILLING		
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED
NOSE ADAPTER RE574000002-1	1	1
COOLANT BUSHING RE574000002-1	-223 1 1	-220 1 1
DRILL TFIM25.0204	-148 1 1	-178 1 1
REAMING PRE-STRESS COIN HOLES IN SUBSTRUCTURE 2		
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED
NOSE ADAPTER RE574000002-1	1	1
COOLANT BUSHING RE374000002-1	-434 -435 -436	-426 -394 -437
REAMER TFIM25.121	-2473 -2623 -3783	-3093 -3255 -3403

LEGEND

1 NOT REQUIRED.

2 STRESS COLD WORK HOLES IN SUBSTRUCTURE USING RE174000002-1 FASTENER HOLE COLD WORKING TOOL SET.

Figure 9. Close Tolerance Hole Fabrication, Repair 80

DEPOT MAINTENANCE

STRUCTURE REPAIR

SHOP PRACTICES

CLOSE TOLERANCE HOLE FABRICATION, REPAIR NUMBERS 81 THRU 90

Reference Material

Structure Repair, General Information	A1-F18AC-SRM-200
Fastener Hole Classification Data	WP004 15

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Record of Applicable Technical Directives

None

1. CLOSE TOLERANCE HOLE FABRICATION.

2. This work package provides guidelines to depot personnel for correct selection of tools and equipment required for close tolerance hole fabrication. To make sure hole integrity is maintained, use of repair numbers is required. For fastener hole classification data, (WP004 15).

3. **REPAIR 81.** See figure 1. Repair 81 is for class 2G holes in aluminum substructure.

4. **REPAIR 81A.** See figure 2. Repair 81A is for class 2G cold worked holes in aluminum substructure.

5. **REPAIR 82.** See figure 3. Repair 82 is for:

a. Class 3 holes in aluminum skin.

b. Class 3 holes in aluminum skin and class 3 holes in aluminum substructure.

c. Class 3 holes in aluminum substructure.

6. **REPAIR 83.** See figure 4. Repair 83 is for:

- a. Class D holes in aluminum skin.
 - b. Class D holes in aluminum skin and class D holes in aluminum substructure.
 - c. Class D holes in aluminum substructure.
7. **REPAIR 83A.** See figure 5. Repair 83A is for class D holes in aluminum substructure.
8. **REPAIR 84.** Data to be supplied when available.
9. **REPAIR 85.** Data to be supplied when available.
10. **REPAIR 86.** See figure 6. Repair 86 is for:
- a. Jo-Bolt holes in aluminum skin.
 - b. Jo-Bolt holes in aluminum skin and Jo-Bolt holes in aluminum substructure.
 - c. Jo-Bolt holes in aluminum substructure.
11. **REPAIR 87.** Data to be supplied when available.
12. **REPAIR 88.** Data to be supplied when available.
13. **REPAIR 89.** Data to be supplied when available.
14. **REPAIR 90.** See figure 7. Repair 90 is for:
- a. Rivet holes in aluminum or titanium skin.
 - b. Rivet holes in aluminum or titanium skin and rivet holes in aluminum or titanium substructure.
 - c. Rivet holes in aluminum or titanium substructure.

REPAIR 81

HOLE COLOR CODE	ORANGE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING					
BUSHING LINER RE374000002-1	1	-103	-103	-101	-102
STEP PIN RE374000002-1	1 1 1	-104 PILOT -105 -106 -107	-104 PILOT -108 -109 -110	-111 PILOT -112 -113 -114	-115 PILOT -116 -117 -118
DRILLING					
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110314-1001 1100-450 RPM POSITIVE FEED	74D110314-1001 1100-450 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	1	-231	-231
COOLANT BUSHING RE574000002-1 SHORT/LONG	1	-223	-220	-D/-CB	-M/-CF
DRILL TFIM25.0204	-108	-148	-178	-200	-220
REAMING SUBSTRUCTURE					
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	1	-232	-232
COOLANT BUSHING RE574000002-1 SHORT/LONG	1 1 1	-101 -102 -103	-104 -105 -106	-F/-CC -H/-CD -K/-CE	-P/-CG -S/-CH -U/-CJ
REAMER TFIM25.121	-1910 -2034 -2190	-2510 -2659 -2815	-3135 -3284 -3440	-3760 -3909 -4065	-4385 -4534 -4690

LEGEND

- 1 NOT REQUIRED.
- 2 SKIN THICKNESS REQUIRES LONGER OR SHORTER BUSHINGS.
(SHORT-1.375/LONG-2.000)

Figure 1. Close Tolerance Hole Fabrication, Repair 81

REPAIR 81A

HOLE COLOR CODE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING				
BUSHING LINER RE374000002-1	-103	-103	-101	-102
STEP PIN RE374000002-1	-104 PILOT -264 -105 -106	-104 PILOT -108 -109 -110	-111 PILOT -112 -113 -114	-115 PILOT -116 -117 -118
DRILLING				
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110314-1001 1100-450 RPM POSITIVE FEED	74D110314-1001 1100-450 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	-231	-231
COOLANT BUSHING 2 RE574000002-1 SHORT/LONG	-389	-392	-DG/-ES	-CW/-CE
DRILL TFIM25.0204	-140	-172	-194	-216
REAMING SUBSTRUCTURE - PRE COLD WORKING				
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	-232	-232
COOLANT BUSHING 2 RE574000002-1 SHORT/LONG	-390 -101 -463	-393 -104 -394	-D/-CB -CU/-DA -CV/-DB	-CX/-DC -CY/-DD -CZ/-DE
REAMER TFIM25.111	-2352 -2512 -2669	-2972 -3133 -3255	-3592 -3752 -3919	-4212 -4372 -4514
REAMING SUBSTRUCTURE 3				
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110314-1009 250 RPM POSITIVE FEED	74D110314-1009 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	-232	-232
COOLANT BUSHING 2 RE574000002-1 SHORT/LONG	-101 -102 -103	-104 -105 -106	-F/-CC -H/-CD -K/-CE	-P/-CG -S/-CH -U/-CJ
REAMER TFIM25.121	-2510 -2659 -2815	-3135 -3284 -3440	-3760 -3909 -4065	-4385 -4534 -4690

LEGEND

- 1 NOT REQUIRED.
- 2 SKIN THICKNESS REQUIRES LONGER OR SHORTER BUSHINGS.
(SHORT - 1.375/LONG - 2.0)
- 3 COLD WORK SUBSTRUCTURE USING RE174000002-1 COLD WORKING FASTENER HOLE TOOL SET

Figure 2. Close Tolerance Hole Fabrication, Repair 81A

REPAIR 82

HOLE COLOR CODE	ORANGE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING					
BUSHING LINER RE374000002-1	1	-103	-103	-101	-102
STEP PIN RE374000002-1	1 1 1	-184 -106 -107	-185 -109 -110	-186 -113 -114	-116 1 1
DRILLING					
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110314-1001 1100-450 RPM POSITIVE FEED	74D110314-1001 1100-450 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	1	-231	-231
COOLANT BUSHING RE574000002-1 SHORT/LONG	2 1	-229	-230	-AX/-DF	-M/-CF
DRILL TFIM25.0235	-191	-252	-315	-377	-421
REAMING SKIN AND SUBSTRUCTURE					
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110314-1001 250 RPM POSITIVE FEED	74D110314-1001 250 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	1	-232	-232
COOLANT BUSHING RE574000002-1 SHORT/LONG	2 1 1	1 -102 -103	1 -105 -106	1 -H/-CD -K/-CE	-P 1 1
REAMER TFIM25.121	1 -2083 -2239	1 -2659 -2815	1 -3284 -3440	1 -3909 -4065	-4385 1 1

Figure 3. Close Tolerance Hole Fabrication, Repair 82 (Sheet 1)

REPAIR 82 (CONTINUED)

HOLE COLOR CODE	ORANGE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
COUNTERSINKING SKIN					
DRILLING MACHINE	3000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP	1000 RPM PISTOL GRIP
NOSE ADAPTER RE574000002-1	1	1	1	1	1
COOLANT BUSHING RE574000002-1	1	1	1	1	1
MICROSTOP CAGE	STANDARD	STANDARD	STANDARD	STANDARD	STANDARD
COUNTERSINK TFIM25.014	-1894 -2014 -2114	-1354 -2624 -2784	-3094 -3254 -3404	-1944 -3874 -4024	-2244 1 1

LEGEND

1 NOT REQUIRED.

2 SKIN THICKNESS REQUIRES LONGER OR SHORTER BUSHINGS.
(SHORT - 1.375/LONG - 2.000)

Figure 3. Close Tolerance Hole Fabrication, Repair 82 (Sheet 2)

REPAIR 83

HOLE COLOR CODE	ORANGE	GREEN	PINK
HOLE SIZE	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.
POTTING			
BUSHING LINER RE374000002-1	TBD	TBD	TBD
STEP PIN RE374000002-1	TBD TBD TBD	TBD TBD TBD	TBD TBD TBD
DRILLING			
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED
NOSE ADAPTER RE574000002-1	1	1	1
COOLANT BUSHING RE574000002-1	TBD	TBD	TBD
DRILL TFIM25.0204	-124	-394	-186
REAMING SKIN AND SUBSTRUCTURE			
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED
NOSE ADAPTER RE574000002-1	1	1	1
COOLANT BUSHING RE574000002-1	1 TBD TBD	1 TBD TBD	1 TBD TBD
REAMER TFIM25.121	1 -2083 -2239	1 -2708 -2864	1 -3378 -3534
COUNTERSINKING SKIN			
DRILLING MACHINE	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP
NOSE ADAPTER RE574000002-1	1	1	1
COOLANT BUSHING RE574000002-1	1	1	1
MICROSTOP CAGE RE574000002-1	STANDARD	STANDARD	STANDARD
COUNTERSINK BODY TFIM25.014	-1904 -2014 -2214	-2534 -2684 -2844	-3194 -3364 -3504

LEGEND

1 NOT REQUIRED.

Figure 4. Close Tolerance Hole Fabrication, Repair 83

REPAIR 83A

HOLE COLOR CODE	ORANGE	GREEN	PINK	VIOLET	YELLOW
HOLE SIZE	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.	5/16 FIRST OVS. SECOND OVS.	3/8 FIRST OVS. SECOND OVS.	7/16 FIRST OVS. SECOND OVS.
POTTING					
BUSHING LINER RE374000002-1	1	-103	-103	-101	-102
STEP PIN RE374000002-1	1 1 1	-122 1 1	-123 1 1	-124 1 1	-117 1 1
DRILLING					
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110314-1001 1100-450 RPM HYDRO CHECK FEED	74D110314-1001 1100-450 RPM POSITIVE FEED
NOSE ADAPTER RE574000002-1	1	1	1	-231	-231
COOLANT BUSHING RE574000002-1	1 1 1	-224 1 1	-222 1 1	-AU 1 1	-S 1 1
DRILL TFIM25.0204	-124	-158	-186	-208	-224

LEGEND

1 NOT REQUIRED.

Figure 5. Close Tolerance Hole Fabrication, Repair 83A

REPAIR 86

HOLE COLOR CODE	SILVER	ORANGE	GREEN
HOLE SIZE	5/32 FIRST OVS. SECOND OVS.	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.
POTTING			
BUSHING LINER RE374000002-1	-179	-179	1
STEP PIN RE374000002-1	-104 PILOT -152 -153 1	-104 PILOT -154 -180 1	1 1 1
DRILLING			
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED
NOSE ADAPTER RE574000002-1	1	1	1
COOLANT BUSHING RE574000002-1	-395	-398	1
DRILL TFIM25.0235	-152	-191	-252
REAMING SKIN AND SUBSTRUCTURE			
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED
NOSE ADAPTER RE574000002-1	1	1	1
COOLANT BUSHING RE574000002-1	-396 -397 1	-399 -400 1	1 1 1
REAMER TFIM25.121	-1650 -1808 1	-1998 -2158 1	-2608 -2767 1

LEGEND

1 NOT REQUIRED.

Figure 6. Close Tolerance Hole Fabrication, Repair 86

REPAIR 90

HOLE COLOR CODE	BLUE	SILVER	ORANGE	GREEN
HOLE SIZE	1/8 FIRST OVS. SECOND OVS.	5/32 FIRST OVS. SECOND OVS.	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.
POTTING				
BUSHING LINER RE374000002-1	TBD	-179	TBD	TBD
STEP PIN RE374000002-1	TBD TBD TBD	-104 -187 1	TBD TBD TBD	TBD TBD TBD
DRILLING				
DRILLING MACHINE	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 500 RPM HYDRO CHECK FEED	74D110316-1001 265 RPM HYDRO CHECK FEED
NOSE ADAPTER RE574000002-1	1	1	1	TBD TBD TBD
COOLANT BUSHING RE574000002-1	TBD	-234	TBD	TBD
DRILL TFIM25.0253	-004	-028	-054	-088
COUNTERSINKING ALUMINUM SKIN				
DRILLING MACHINE	3000 RPM PISTOL GRIP	3000 RPM PISTOL GRIP	3000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP
MICROSTOP CAGE	STANDARD	STANDARD	STANDARD	STANDARD
COUNTERSINK TITANIUM SKIN				
DRILLING MACHINE	250 RPM PISTOL GRIP	250 RPM PISTOL GRIP	250 RPM PISTOL GRIP	250 RPM PISTOL GRIP
NOSE ADAPTER RE574000002-1	1	1	1	1
COOLANT BUSHING RE574000002-1	1	1	1	1
MICROSTOP CAGE	STANDARD	STANDARD	STANDARD	STANDARD
COUNTERSINKING SKIN				
COUNTERSINK TFIM25.	013-674 TBD TBD	014-0824 TBD TBD	014-1894 TBD TBD	014-2534 TBD TBD

LEGEND

1 NOT REQUIRED.

Figure 7. Close Tolerance Hole Fabrication, Repair 90

DEPOT MAINTENANCE

STRUCTURE REPAIR

SHOP PRACTICES

CLOSE TOLERANCE HOLE FABRICATION, REPAIR NUMBERS 91 THRU 99

Reference Material

Structure Repair, General Information	A1-F18AC-SRM-200
Fastener Hole Classification Data	WP004 15

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Record of Applicable Technical Directives

None

1. CLOSE TOLERANCE HOLE FABRICATION.

2. This work package provides guidelines to depot personnel for correct selection of tools and equipment required for close tolerance hole fabrication. To make sure hole integrity is maintained, use of repair numbers is required. For fastener hole classification data, (WP004 15).

3. **REPAIR 91.** Data to be supplied when available.

4. **REPAIR 92.** See figure 1. Repair 92 is for:

a. Countersunk and counterbored fast rivet holes in aluminum or titanium skin.

b. Rivet holes in aluminum or titanium substructure.

5. **REPAIR 93.** Data to be supplied when available.

6. **REPAIR 94.** Data to be supplied when available.

7. **REPAIR 95.** Data to be supplied when available.

8. **REPAIR 96.** Data to be supplied when available.

9. **REPAIR 97.** Data to be supplied when available.

10. **REPAIR 98.** Data to be supplied when available.

11. **REPAIR 99.** Data to be supplied when available.

REPAIR 92

HOLE COLOR CODE	BLUE	SILVER	ORANGE	GREEN
HOLE SIZE	1/18 FIRST OVS. SECOND OVS.	5/32 FIRST OVS. SECOND OVS.	3/16 FIRST OVS. SECOND OVS.	1/4 FIRST OVS. SECOND OVS.
POTTING				
BUSHING LINER RE374000002-1	1	-179	1	1
STEP PIN RE374000002-1	1 1 1	-104 PILOT -187 1 1	1 1 1	1 1 1
DRILLING				
DRILLING MACHINE	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED	74D110316-1001 2000 RPM HYDRO CHECK FEED
NOSE ADAPTER RE574000002-1	1	1	1	1
COOLANT BUSHING RE574000002-1	1	-234	1	1
DRILL TFIM25.0204	-074	-098	-124	-394
COUNTERSINKING SKIN				
DRILLING MACHINE	3000 RPM PISTOL GRIP	3000 RPM PISTOL GRIP	3000 RPM PISTOL GRIP	2000 RPM PISTOL GRIP
NOSE ADAPTER RE574000002-1	1	1	1	1
COOLANT BUSHING RE574000002-1	1	1	1	1
MICROSTOP CAGE 2	FSA-30-1	FSA-30-1	FSA-30-1	FSA-20-1
COUNTERSINK COUNTERBORE CUTTER 2	FSC-4	FSC-5	FSC-6	FSC-8

LEGEND

- 1 NOT REQUIRED
- 2 BRILES RIVET CORP, CAGE 55580.

Figure 1. Close Tolerance Hole Fabrication, Repair 92

DEPOT MAINTENANCE

STRUCTURE REPAIR

SHOP PRACTICES

WING LUGS OR FUSELAGE WING ATTACH LUGS BUSHING INSTALLATION KIT

PART NO. RE974110002-1

Reference Material

Structure Repair, General Information	A1-F18AC-SRM-200
Hydraulic Pump Assembly, Pneumatic	WP004 18

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Record of Applicable Technical Directives

None

1. WING LUGS OR FUSELAGE WING ATTACH LUGS BUSHING INSTALLATION KIT.

2. The wing lugs or fuselage wing attach bushing installation kit (bushing installation kit) is made up of various spacers, mandrels, tubes, draw rods, removal tools, bucking tools, bushing shields, and support rings. The bushing installation kit is used to remove and install any nominal or oversized bushing without having to remove nearby bushings. Bushing shields are added to protect nearby bushings. Support rings are provided to aid in supporting weight of assembled tools. These tools interface with hydraulic cylinders for bushing removal and installation.



Measure wall thickness of removed bushing. If wall thickness exceeds 0.090, request engineering disposition for bushing installation.

3. PROCEDURES.

4. WING LUGS BUSHING REMOVAL.

NOTE

These tools may be used in forward to aft or aft to forward directions.

5. Upper Bushings, After Final Ream. See figure 1.

- a. Install removal tool (detail 104), view A, into bushing to be removed.
- b. Install draw rod (detail 110), view B, through removal tool (detail 104), view A, lug support (detail 184), view C, and RCH123 hydraulic cylinder (hyd. cyl.).
- c. Secure removal tool (detail 104), view A, draw rod (detail 110), view B, lug support (detail 184), view C, and hyd. cyl. in position with flanged nut (detail 174), view B. Make sure removal tool (detail 104), view A, and lug support (detail 184), view C, are next to bushing to be removed and lug.
- d. Connect pneumatic hydraulic pump assembly (hyd. pump) to hyd. cyl. (WP004 18).

e. Actuate hyd. cyl. using hyd. pump to remove bushing.

f. Disconnect hyd. pump from hyd. cyl.

g. Remove flanged nut (detail 174), view B, to remove hyd. cyl. lug support (detail 184), view C, draw rod (detail 110), view B, and removal tool (detail 104), view A.

h. Repeat steps a through g for remaining upper wing lugs.

NOTE

These tools may be used in forward to aft or aft to forward directions.

6. Upper Bushings, Pre-ream. See figure 1.

a. Install removal tool (detail 105), view A, into bushing to be removed.

b. Install draw rod (detail 110), view B, through removal tool (detail 105), view A, lug support (detail 184), view C, and hyd. cyl.

c. Secure removal tool (detail 105), view A, draw rod (detail 110), view B, lug support (detail 184), view C, and hyd. cyl. in position with flanged nut (detail 174), view B. Make sure removal tool (detail 105), view A, and lug support (detail 184), view C, are next to bushing to be removed and lug.

d. Connect hyd. pump to hyd. cyl. (WP004 18).

e. Actuate hyd. cyl. using hyd. pump to remove bushing.

f. Disconnect hyd. pump from hyd. cyl.

g. Remove flanged nut (detail 174), view B, to remove hyd. cyl. lug support (detail 184), view C, draw rod (detail 110), view B, and removal tool (detail 105), view A.

h. Repeat steps a through g for remaining upper wing lugs.

NOTE

These tools may be used in forward to aft or aft to forward directions.

7. Lower Bushings, After Final Ream. See figure 1.

a. Install removal tool (detail 137), view A, into bushing to be removed.

b. Install draw rod (detail 110), view B, through removal tool (detail 137), view A, lug support (detail 109), view C, and hyd. cyl.

c. Secure removal tool (detail 137), view A, draw rod (detail 110), view B, lug support (detail 109), view C, and hyd. cyl. in position with flanged nut (detail 174), view B. Make sure removal tool (detail 137), view A, and lug support (detail 109), view C, are next to bushing to be removed and lug.

d. Connect hyd. pump to hyd. cyl. (WP004 18).

e. Actuate hyd. cyl. using hyd. pump to remove bushing.

f. Disconnect hyd. pump from hyd. cyl.

g. Remove flanged nut (detail 174), view B, to remove hyd. cyl, lug support (detail 109), view C, draw rod (detail 110), view B, and removal tool (detail 137), view A.

h. Repeat steps a through g for remaining lower wing lugs.

NOTE

These tools may be used in a forward to aft or aft to forward directions.

8. Lower Bushings, Pre-ream. See figure 1.

a. Install removal tool (detail 138), view A, into bushing to be removed.

b. Install draw rod (detail 110), view B, through removal tool (detail 138), view A, lug support (detail 109), view C, and hyd. cyl.

c. Secure removal tool (detail 138), view A, draw rod (detail 110), view B, lug support (detail 109), view C, and hyd. cyl. in position with flanged nut (detail 174), view B. Make sure removal tool (detail 138), view A, and lug support (detail 109), view C, are next to bushing to be removed and lug.

d. Connect hyd. pump to hyd. cyl. (WP004 18).

e. Actuate hyd. cyl. using hyd. pump to remove bushing.

f. Disconnect hyd. pump from hyd. cyl.

g. Remove flanged nut (detail 174), view B, to remove hyd. cyl, lug support (detail 109), view C, draw rod (detail 110), view B, and removal tool (detail 138), view A.

h. Repeat steps a through g for remaining lower wing lugs.

9. WING LUGS BUSHING INSTALLATION.

Support Equipment Required

Part Number or Type Designation	Nomenclature
RCH306	Hydraulic Cylinder
RCH603	Hydraulic Cylinder

Materials Required

Specification or Part Number	Nomenclature
3034T31	Split Ring Hanger, McMaster Carr, Detail 147
8890T16	Drop Forged Lifting Eye, McMaster Carr, Detail 148
2-329	0-ring Packing, Parker, Detail 173
2-330	0-ring Packing, Parker, Detail 146, 2 Req'd.
2-332	0-ring Packing, Parker, Detail 142
2-333	0-ring Packing, Parker, Detail 143, 2 Req'd.
—	Socket Head, Cap Screw, 1/2 - 13 X 1-1/2, Detail 141

NOTE

These tools may be used in a forward to aft or aft to forward direction.

10. Upper Wing Lugs. See figure 2.

a. Insert correct bushing into wing lug, slip fit.

b. Install mandrel (detail 125), view A, into wing lug bushing and through wing lug supports (details 112 and 111), views B and C. Details 112 and 111 are screwed together with two 0-ring packings (detail 146).

c. Assemble draw rod tube (detail 119), view D, draw rod (detail 121), view E, mounting plate (detail 123), view F, RCH603 60 ton hydraulic cylinder (hyd. cyl.), and cylinder saddle (detail 124), view L.

d. Install split ring hanger (detail 147), and forged lifting eye (detail 148) on to draw rod tube, (detail 119), view D, and support ring (details 175, 176, 177, 178, and 179), view G, to hyd. cyl.

e. Attach holding device to support rings to carry weight of assembled tools.

f. Slide assembly, substeps (b) through (d) through forward and center wing lugs.

g. Thread bucking tool (detail 117), view H, onto draw rod tube (detail 119), view D.

h. Install bucking insert (detail 115), view J, and O-ring (detail 173), view J, into bucking tool (detail 117), view H.

i. Slide draw rod (detail 121), view E, aft through wing lug supports (details 112 and 111), views B and C.

j. Thread mandrel (detail 125), view A, onto draw rod (detail 121), view E.

k. Unscrew wing lug supports (details 112 and 111), views B and C until tight against sides of wing lugs.

l. Push mandrel (detail 125), view A, and draw rod (detail 121), view E, forward engaging mandrel in wing lug bushing.

m. Slide assembled tools aft until against wing lug.

n. With hyd. cyl. fully retracted, thread knurled nut (detail 180), view K, onto draw rod (detail 121), view E.

o. Connect hyd. pump to hyd. cyl. (WP004 18).

p. Actuate hyd. cyl. using hyd. pump to pull mandrel (detail 125), view A, through first wing lug. This force mates bushing into aft wing lugs.

q. Retract hyd. cyl. fully using hyd. pump.

r. Reset knurled nut (detail 180), view K, against cylinder saddle (detail 124), view L.

s. Actuate hyd. cyl. using hyd. pump to pull mandrel (detail 125), view A, through second wing lug. This force mates bushing into forward wing lugs.

t. Repeat steps a. through s. for remaining upper wing lugs.

NOTE

These tools may be used in a forward to aft or aft to forward direction.

11. **Lower Wing Lugs.** See figure 2.

a. Insert correct bushing into wing lug, slip fit.

b. Install mandrel (detail 126), view A, into wing lug bushing and through wing lug supports (detail 114 and 113), views B and C. Details 114 packings and 113 are screwed together with two O-rings (detail 143).

c. Assemble draw rod tube (detail 185), view D, draw rod (detail 122), view E, mounting plate (detail 123), view F, with two socket head cap screws (detail 141), view F, RCH603 60 ton hydraulic cylinder (hyd. cyl.), and cylinder saddle (detail 124), view L.

d. Install split ring hanger (detail 147), forged lifting eye (detail 148), on to draw rod tube (detail 185) view D, and support ring (details 175, 176, 177, 178, and 179), view G, on to hyd. cyl.

e. Attach holding device to support rings to carry weight of assembled tools.

f. Slide assembly, steps (b) through (d) through forward and center wing lugs.

g. Thread bucking tool (detail 118), view H, onto draw rod tube (detail 185), view D.

h. Install bucking insert (detail 116), view J, and O-ring (detail 143), into bucking tool (detail 118), view H.

i. Slide draw rod (detail 122), view E, aft through wing lug supports (details 114 and 113), views B and C.

j. Thread mandrel (detail 126), view A, onto draw rod (detail 122), view E.

k. Unscrew wing lug supports (details 114 and 113), views B and C until tight against sides of wing lugs.

l. Push mandrel (detail 126), view A, draw rod (detail 122), view E, forward engaging mandrel in wing lug bushing.

m. Slide assembled tools aft until against wing lug.

n. With hyd. cyl. fully retracted, thread knurled nut (detail 180), view K, onto draw rod (detail 122), view E.

o. Connect hyd. pump to hyd. cyl. (WP004 18).

p. Actuate hyd. cyl. using hyd. pump to pull mandrel (detail 126), view A, through first wing lug. This force mates bushing into aft wing lug.

q. Retract hyd. cyl. using hyd. pump.

r. Reset knurled nut (detail 180), view K, against cylinder saddle (detail 124), view L.

s. Actuate hyd. cyl. using hyd. pump to pull mandrel (detail 126), view A, through second wing lug. This force mates bushing into forward wing lug.

t. Repeat steps a. through s. for remaining lower wing lugs.

12. FUSELAGE WING ATTACH LUGS, BUSHING REMOVAL.

13. **Upper Bushings, After Ream.** See figure 3.

a. Position of tools at attach point:

(1) 74A324202, forward to aft.

(2) 74A324204, forward to aft or aft to forward.

(3) 74A324206, aft to forward.

NOTE

Make sure hyd. cyl. is in full retract position.

b. Attach RCH306 hyd. cyl to RE97411002-S-A subassembly (subassy) by sliding draw rod (detail 186), view A, with knurled nut (detail 163), view B, through subassy.

c. Thread bucking tool (detail 129), view C, into subassy.

d. Make sure hoist rings (detail 164) are in position on subassy.

e. Position hoist sling, depot furnished, around hyd. cyl.

f. Position hoist, depot furnished, above 74A324202, upper forward fuselage attach point, and attach to hoist ring and sling.

g. Thread removal tool (detail 107), view D, onto shaft (detail 181), view E.

h. Install this assembly through 74A324915 bushing from forward side through bucking tool (detail 129), view C, into subassy.

NOTE

Make sure removal tool and bucking tool are tight against 74A324202 bulkhead at attach point.

i. Lock tools together with knurled nut (detail 150), view B.

j. Connect hyd. pump to hyd. cyl. (WP004 18).

k. Actuate hyd. cyl. using hyd. pump. This pulls removal tool (detail 107), view D, through attach point removing 74A324915 bushing.

l. Disconnect hyd. pump from hyd. cyl.

m. Remove tools from attach point.

14. **Upper Bushings, Pre-ream.** See figure 3.

a. Position of tools at attach point:

(1) 74A324202, forward to aft.

(2) 74A324204, forward to aft or aft to forward.

(3) 74A324206, aft to forward.

NOTE

Make sure hyd. cyl. is in full retract position.

- b. Attach RCH306 hyd. cyl to subassy by sliding draw rod (detail 186), view A, with knurled nut (detail 163), view B, through subassy.
- c. Thread bucking tool (detail 129), view C, into subassy.
- d. Make sure hoist rings (detail 164) are in position on subassy.
- e. Position hoist sling, depot furnished, around hyd. cyl.
- f. Position hoist, depot furnished, at 74A324202, upper forward fuselage attach point, above support tools.
- g. Thread removal tool (detail 106), view D, onto shaft (detail 181), view E.
- h. Install this assembly through 74A324915 bushing from forward side through bucking tool (detail 129), view C, into subassy.

NOTE

Make sure removal tool and bucking tool are tight against 74A324202 bulkhead at attach point.

- i. Lock tools together with knurled nut (detail 150), view B.
 - j. Connect hyd. pump to hyd. cyl. (WP004 18).
 - k. Actuate hyd. cyl. using hyd. pump. This pulls removal tool (detail 106), view D, through attach point removing 74A324915 bushing.
 - l. Disconnect hyd. pump from hyd. cyl.
 - m. Remove tools from attach point.
15. **Lower Bushings, After Ream.** See figure 3.
- a. Position of tools at attach point:

(1) 74A324202, forward to aft.

(2) 74A324204, forward to aft or aft to forward.

(3) 74A324206, aft to forward.

NOTE

Make sure hyd. cyl is in full retract position.

- b. Attach RCH306 hyd. cyl to subassy by sliding draw rod (detail 186), view A, with knurled nut (detail 163), view B, through subassy.
- c. Thread bucking tool (detail 130), view C, into subassy.
- d. Make sure hoist rings (detail 164) are in position on subassy.
- e. Position hoist sling, depot furnished, around hyd. cyl.
- f. Position hoist, depot furnished, above 74A324202, upper forward fuselage attach point, and attach to hoist ring and sling.
- g. Thread removal tool (detail 140), view D, onto shaft (detail 181), view E.
- h. Install this assembly through 74A324915 bushing from forward side through bucking tool (detail 130), view C, into subassy.

NOTE

Make sure removal tool and bucking tool are tight against 74A324202 bulkhead at attach point.

- i. Lock tools together with knurled nut (detail 150), view B.
- j. Connect hyd. pump to hyd. cyl. (WP004 18).
- k. Actuate hyd. cyl. using hyd. pump. This pulls removal tool (detail 140), view D, through attach point removing 74A324915 bushing.
- l. Disconnect hyd. pump from hyd. cyl.
- m. Remove tools from attach point.

16. **Lower Bushings, Pre-Ream.** See figure 3.

a. Position of tools at attach point:

(1) 74A324202, forward to aft.

(2) 74A324204, forward to aft or aft to forward.

(3) 74A324206, aft to forward.

NOTE

Make sure hyd. cyl. is in full retract position.

b. Attach RCH306 hyd. cyl to subassy by sliding draw rod (detail 149), view A, with knurled nut (detail 163), view B, through subassy.

c. Thread bucking tool (detail 130), view C, into subassy.

d. Make sure hoist rings (detail 164) are in position on subassy.

e. Position hoist sling, depot furnished, around hyd. cyl.

f. Position hoist, depot furnished, above 74A324202, upper forward fuselage attach point, and attach to hoist ring and sling.

g. Thread removal tool (detail 139), view D, onto shaft (detail 181), view E.

h. Install this assembly through 74A324915 bushing from forward side through bucking tool (detail 130), view C, into subassy.

NOTE

Make sure removal tool and bucking tool are tight against 74A324202 bulkhead at attach point.

i. Lock tools together with knurled nut (detail 150), view B.

j. Connect hyd. pump to hyd. cyl. (WP004 18).

k. Actuate hyd. cyl. using hyd. pump. This pulls removal tool (detail 139), view D, through attach point removing 74A324915 bushing.

l. Disconnect hyd. pump from hyd. cyl.

m. Remove tools from attach point.

17. FUSELAGE WING ATTACH LUGS BUSHING INSTALLATION.

18. **Upper Bushings.** See figure 4.

a. Position of tools at attach point:

(1) 74A324202, forward to aft.

(2) 74A324204, forward to aft or aft to forward.

(3) 74A324206, aft to forward.

NOTE

Make sure hyd. cyl. is in full retract position.

b. Attach RCH306 hyd. cyl to subassy by sliding draw rod (detail 157), view A, with knurled nut (detail 163), view B, through subassy.

c. Thread bucking tool (detail 131), view C, into subassy.

d. Make sure hoist rings (detail 164) are in position on subassy.

e. Position hoist sling, depot furnished, around hyd. cyl.

f. Position hoist, depot furnished, above 74A324202, upper forward fuselage attach point, and attach hoist ring and sling.

g. Thread mandrel (detail 127), view D, onto shaft (detail 149), view E.

h. Install this assembly through 74A324915 bushing from forward side through bucking tool (detail 131), view C, into subassy.

NOTE

Make sure removal tool and bucking tool are tight against 74A324202 bulkhead at attach point.

i. Lock tools together with knurled nut (detail 150), view B.

j. Connect hyd. pump to hyd. cyl. (WP004 18).

k. Actuate hyd. cyl. using hyd. pump. This pulls mandrel (detail 127), view D, through attach point, force mating 74A324915 bushing.

l. Disconnect hyd. pump from hyd. cyl.

m. Remove tools from attach point.

19. Lower Bushings. See figure 4.

a. Position of tools at attach point:

(1) 74A324202, forward to aft.

(2) 74A324204, forward to aft or aft to forward.

(3) 74A324206, aft to forward.

NOTE

Make sure hyd. cyl. is in full retract position.

b. Attach RCH306 hyd. cyl to subassy by sliding draw rod (detail 157), view A, with knurled nut (detail 163), view B, through subassy.

c. Thread bucking tool (detail 132), view C, into subassy.

d. Make sure hoist rings (detail 164) are in position on subassy.

e. Position hoist sling, depot furnished, around hyd. cyl.

f. Position hoist, depot furnished, above 74A324202, upper forward fuselage attach point, and attach to hoist ring and sling.

g. Thread mandrel (detail 128), view D, onto shaft (detail 149), view E.

h. Install this assembly through 74A324915 bushing from forward side through bucking tool (detail 132), view C, into subassy.

NOTE

Make sure removal tool and bucking tool are tight against 74A324202 bulkhead at attach point.

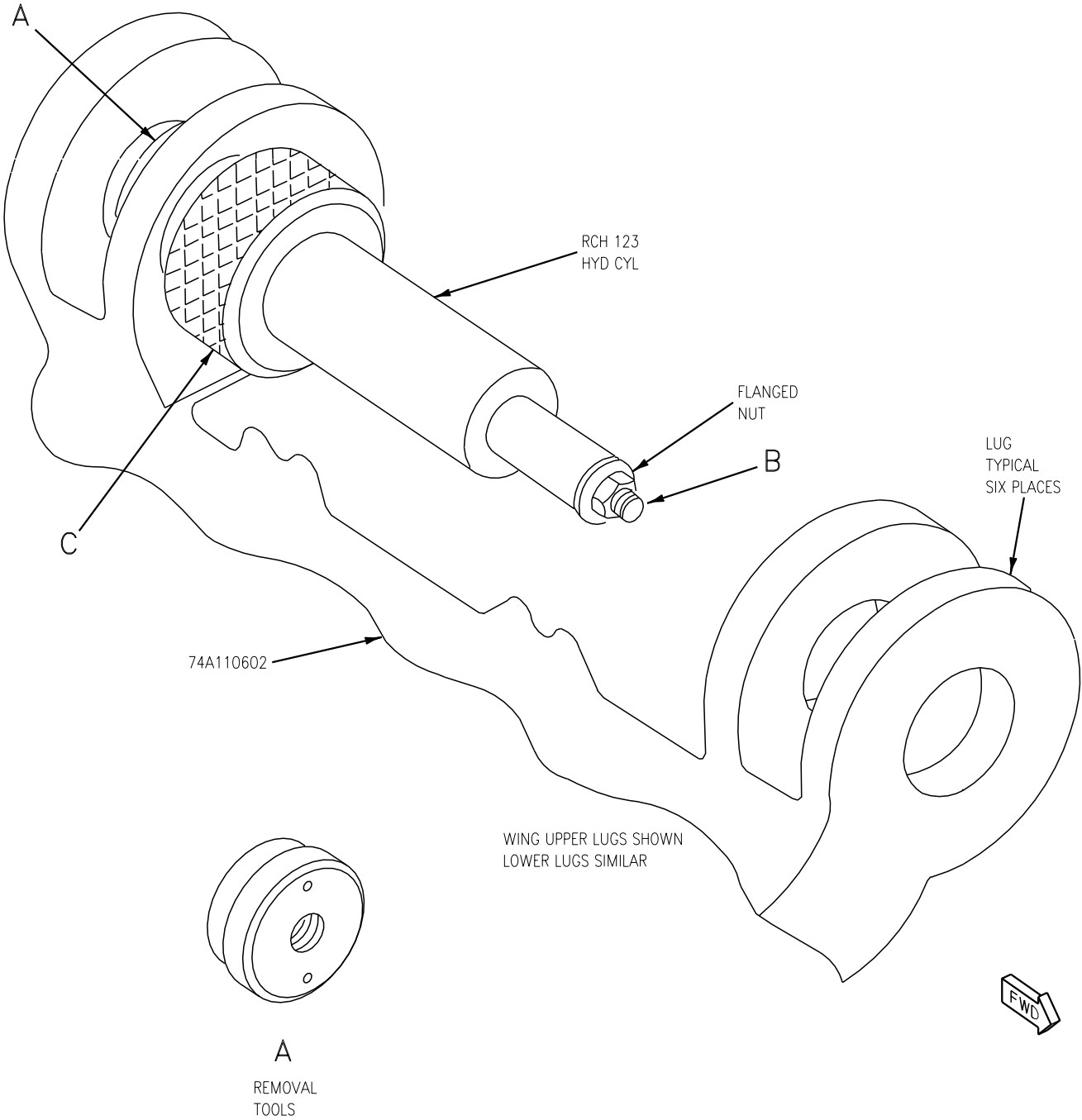
i. Lock tools together with knurled nut (detail 150), view B.

j. Connect hyd. pump to hyd. cyl. (WP004 18).

k. Actuate hyd. cyl. using hyd. pump. This pulls mandrel (detail 128), view D, through attach point removing 74A324915 bushing.

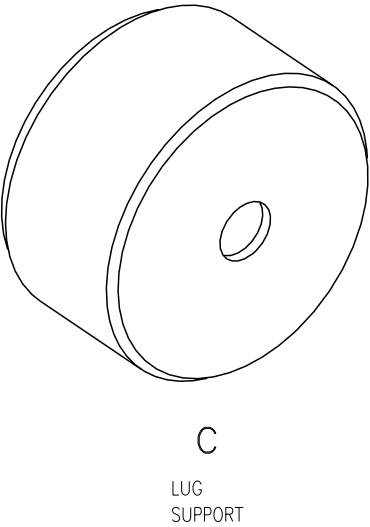
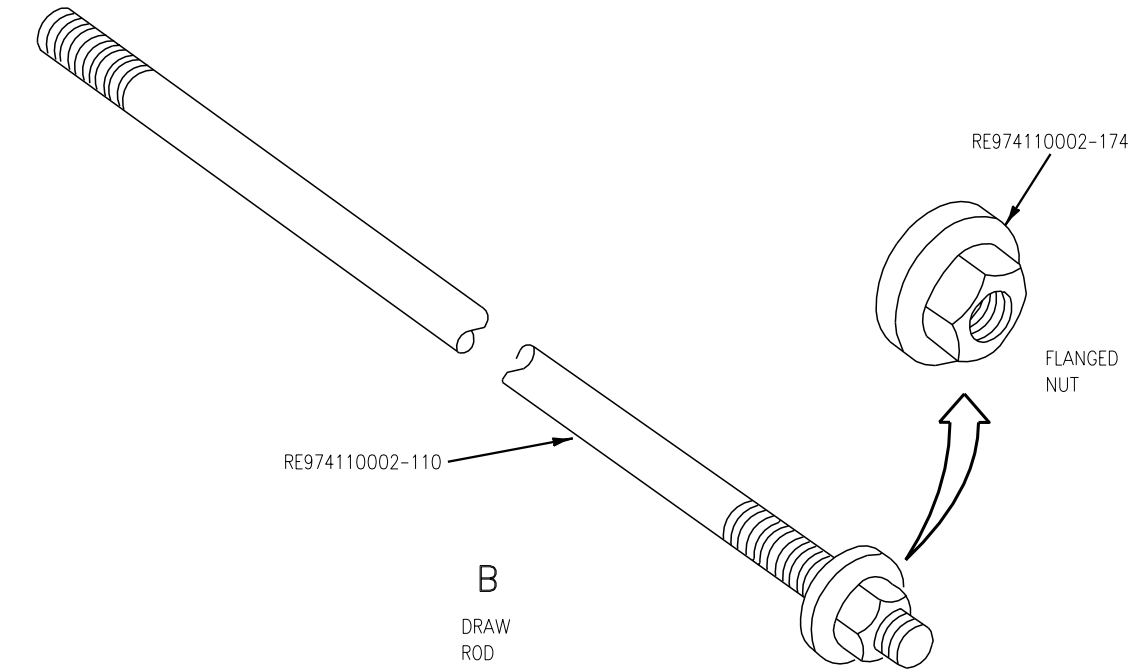
l. Disconnect hyd. pump from hyd. cyl.

m. Remove tools from attach point.



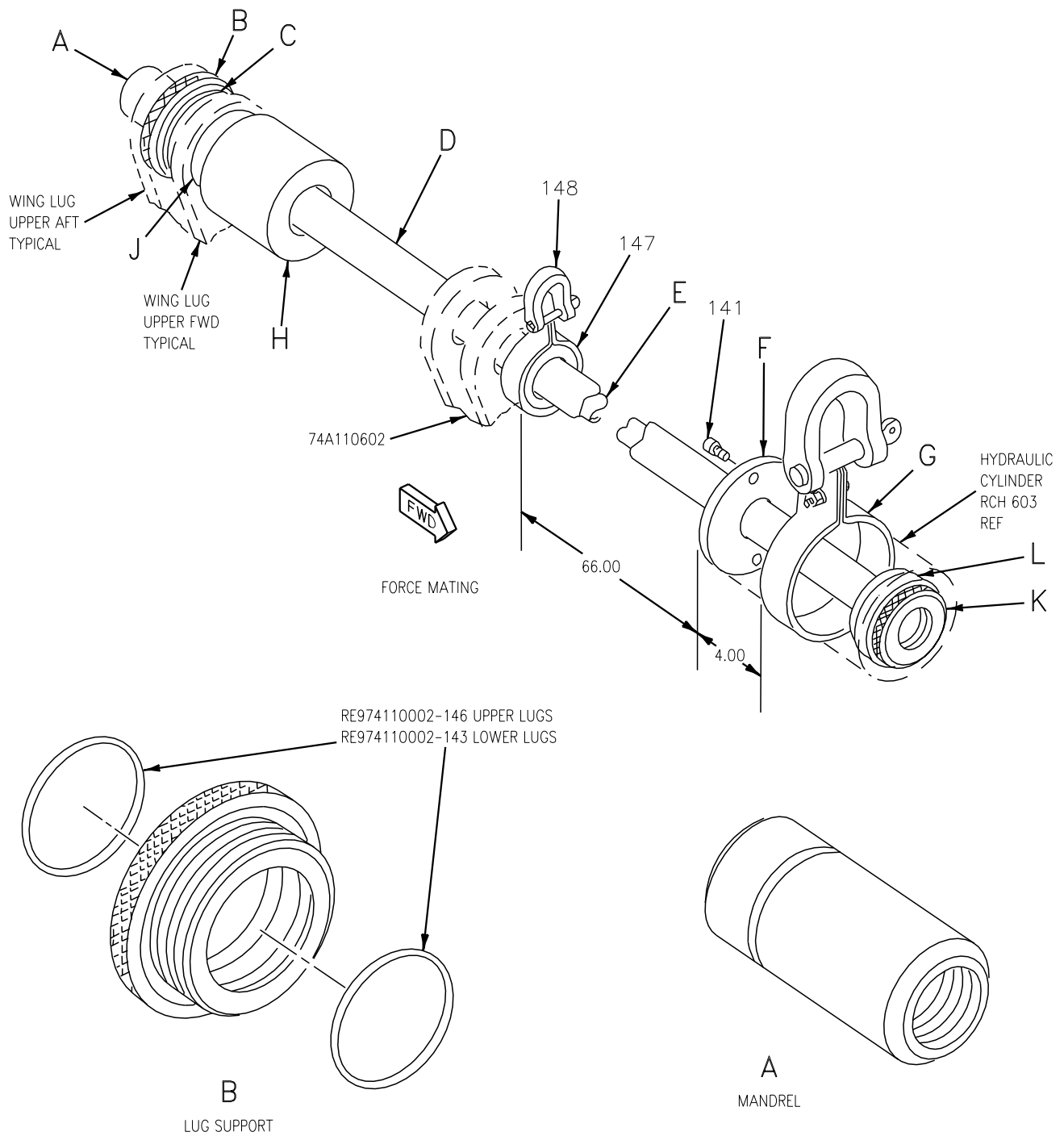
DETAIL NUMBER	USE ON
RE974110002-104	UPPER LUGS
RE974110002-105	UPPER LUGS
RE974110002-137	LOWER LUGS
RE974110002-138	LOWER LUGS

Figure 1. Wing Lug Bushing Removal (Sheet 1)



DETAIL NUMBER	USE ON
RE974110002-184	UPPER LUGS
RE974110002-109	LOWER LUGS

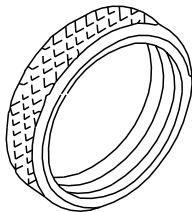
Figure 1. Wing Lug Bushing Removal (Sheet 2)



DETAIL NUMBER	USE ON
RE974110002-112	UPPER LUGS
RE974110002-114	LOWER LUGS

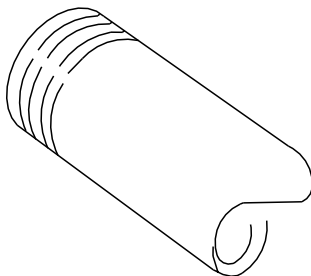
DETAIL NUMBER	USE ON
RE974110002-125	UPPER LUGS
RE974110002-126	LOWER LUGS

Figure 2. Wing Lug Bushing Installation (Sheet 1)



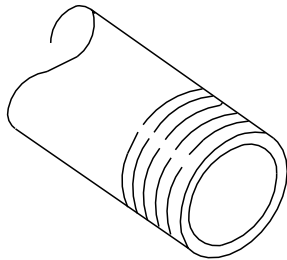
C
LUG
SUPPORT

DETAIL NUMBER	USE ON
RE974110002-111	UPPER LUGS
RE974110002-113	LOWER LUGS



D
DRAW ROD
TUBE

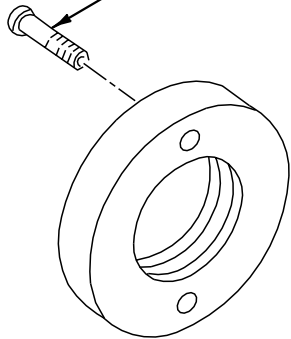
DETAIL NUMBER	USE ON
RE974110002-119	UPPER LUGS
RE974110002-185	LOWER LUGS



E
DRAW
ROD

DETAIL NUMBER	USE ON
RE974110002-121	UPPER LUGS
RE974110002-122	LOWER LUGS

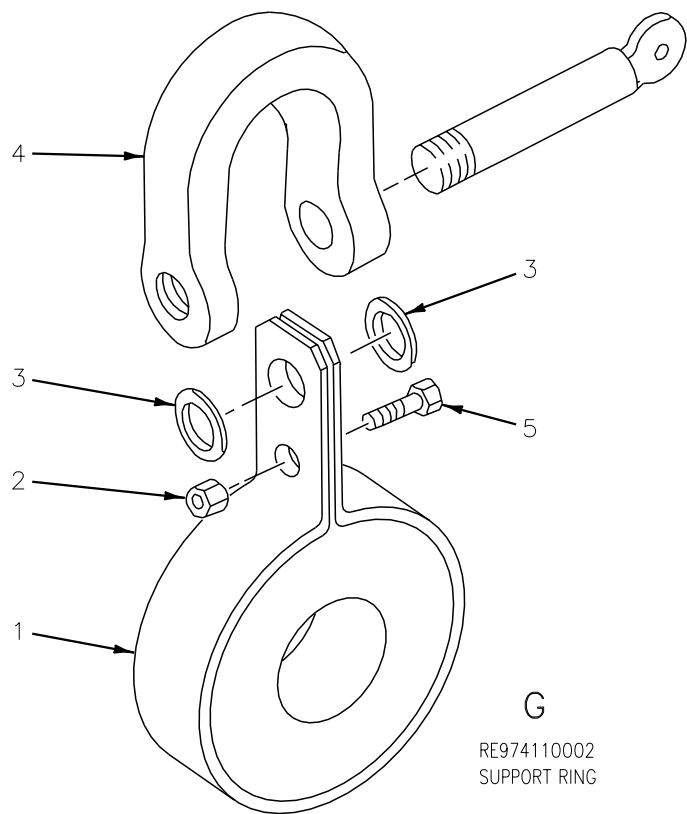
RE974110002-141
SOCKET HEAD
CAP SCREW



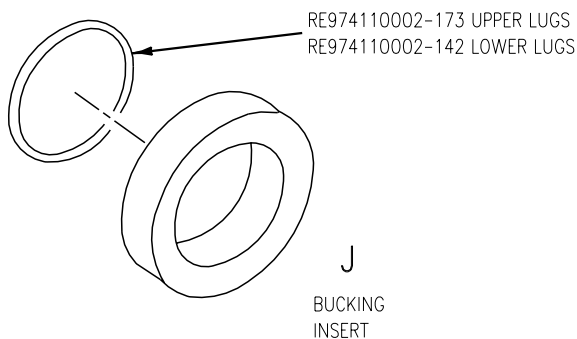
F
MOUNTING
PLATE

DETAIL NUMBER	USE ON
RE974110002-123	UPPER LUGS
	LOWER LUGS

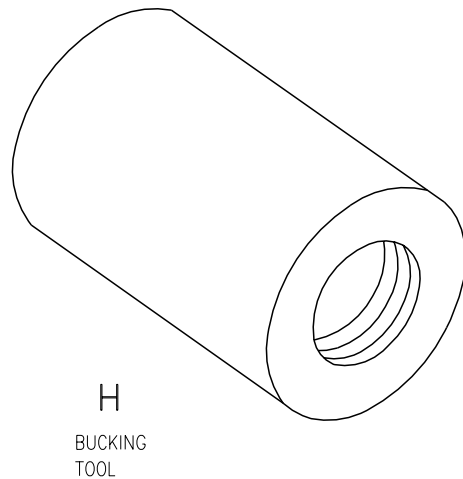
Figure 2. Wing Lug Bushing Installation (Sheet 2)



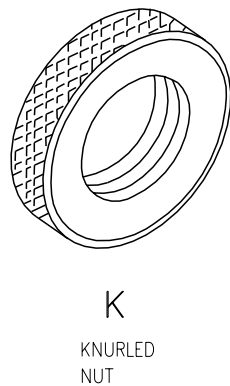
ITEM	DETAIL	NOMENCLATURE
1	RE974110002-175	SUPPORT RING
2	RE974110002-176	3/8-16 HEX NUT
3	RE974110002-178	1/2 ID WASHER
4	RE974110002-177	CTS535B-2 EYE
5	RE974110002-179	3/8-16 X 3/4 HEX HEAD BOLT



DETAIL NUMBER	USE ON
RE974110002-115 RE974110002-116	UPPER LUGS LOWER LUGS

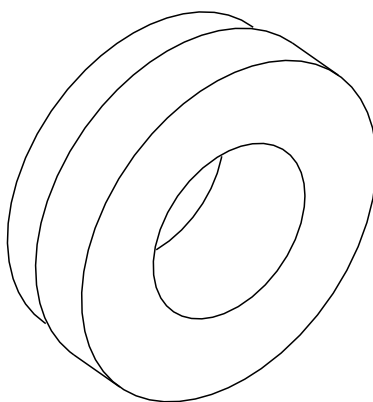


DETAIL NUMBER	USE ON
RE974110002-117 RE974110002-118	UPPER LUGS LOWER LUGS



DETAIL NUMBER	USE ON
RE974110002-180	UPPER LUGS LOWER LUGS

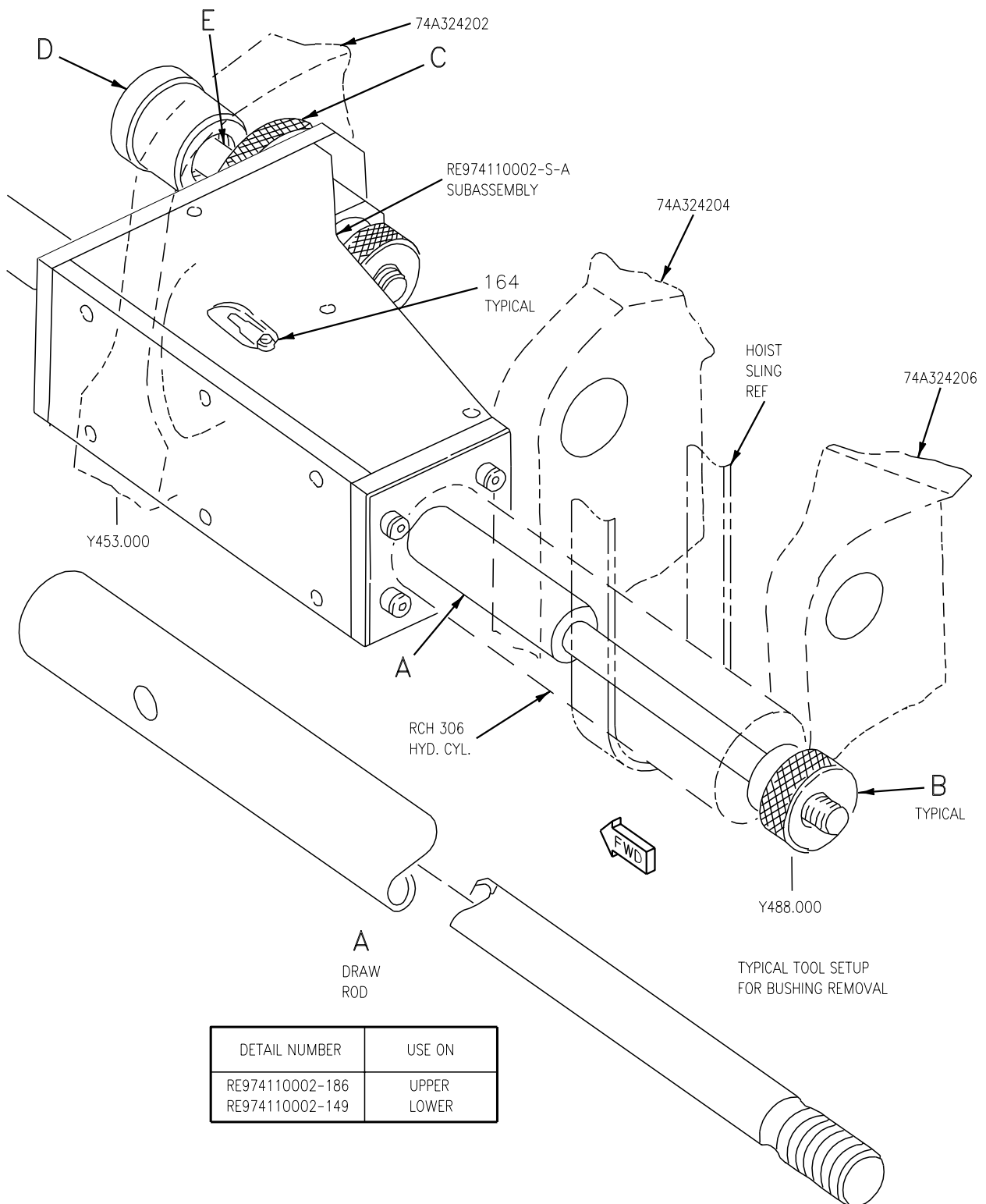
Figure 2. Wing Lug Bushing Installation (Sheet 3)



L

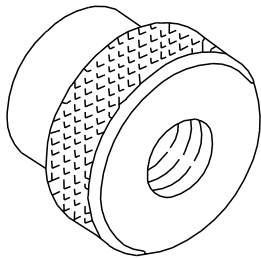
RE974110002-124
CYLINDER SADDLE

Figure 2. Wing Lug Bushing Installation (Sheet 4)



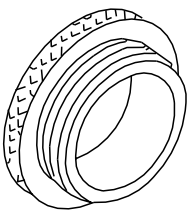
DETAIL NUMBER	USE ON
RE974110002-186	UPPER
RE974110002-149	LOWER

Figure 3. Fuselage Wing Attach Lugs Bushing Removal (Sheet 1)



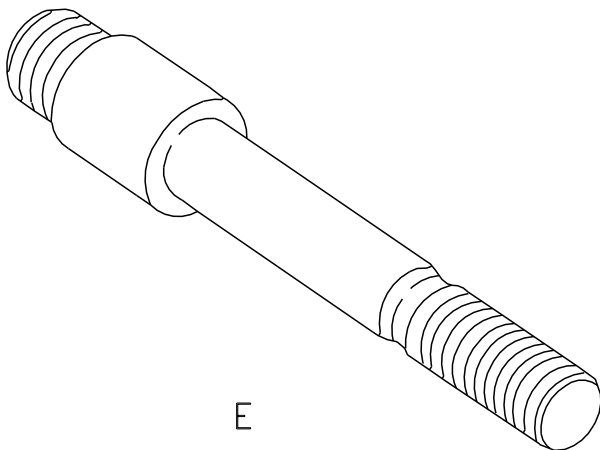
B
KNURLED
NUT

DETAIL NUMBER	USE ON
RE974110002-163	VIEW A
RE974110002-150	VIEW E



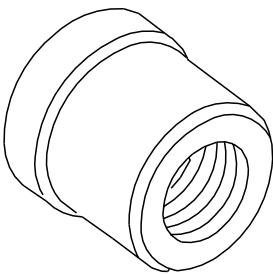
C
BUCKING
TOOL

DETAIL NUMBER	USE ON
RE974110002-129	UPPER REMOVAL
RE974110002-130	LOWER REMOVAL



E
SHAFT

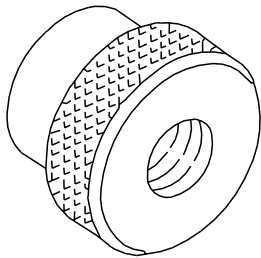
DETAIL NUMBER	USE ON
RE974110002-181	UPPER AND LOWER



D
REMOVAL
TOOL

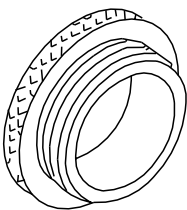
DETAIL NUMBER	USE ON
RE974110002-106	UPPER
RE974110002-107	UPPER
RE974110002-139	LOWER
RE974110002-140	LOWER

Figure 3. Fuselage Wing Attach Lugs Bushing Removal (Sheet 2)



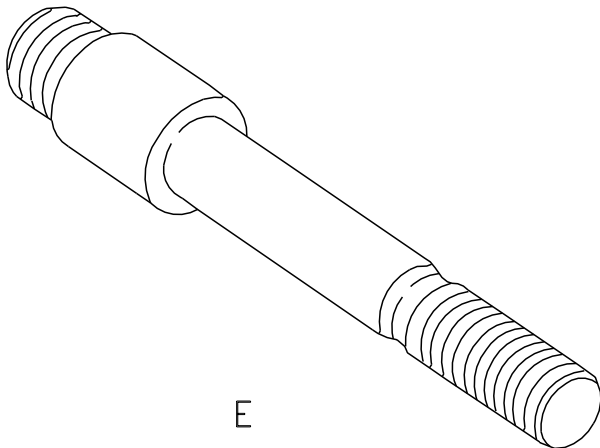
B
KNURLED
NUT

DETAIL NUMBER	USE ON
RE974110002-163	VIEW A
RE974110002-150	VIEW E



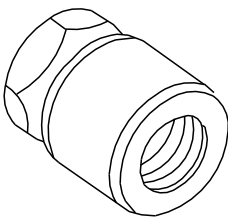
C
BUCKING
TOOL

DETAIL NUMBER	USE ON
RE974110002-131	UPPER
RE974110002-132	LOWER



E
SHAFT

DETAIL NUMBER	USE ON
RE974110002-149	UPPER AND LOWER



D
MANDREL

DETAIL NUMBER	USE ON
RE974110002-127	UPPER
RE974110002-128	LOWER

Figure 4. Fuselage Wing Attach Lugs Bushing Installation (Sheet 2)

DEPOT MAINTENANCE

STRUCTURE REPAIR

BUSHING REMOVAL, INSTALLATION, AND REAMING TOOL SET

PART NO. 74D110174-1001

Reference Material

None

Alphabetical Index

Subject	Page No.
Bushing Removal, Installation, and Reaming Tool Set	1
General.....	1
Procedures.....	2

Record of Applicable Technical Directives

None

1. **BUSHING REMOVAL, INSTALLATION, AND REAMING TOOL SET.** See figures 1, 2, 3, and 4.

2. The bushing removal, installation, and reaming tool set (tool set) is used on F/A-18 aircraft because of many hinge points on inner and outer wing flight control surfaces and speed brake. These hinge points and their related bushings are shown in figures 1 and 2. Press fit type bushings wear due to use or can be damaged during removal and installation of flight control surfaces. This work package contains data required to remove damaged bushings, install new bushings, and in most cases ream bushings to final size.

3. **GENERAL.**

a. The tool set consists of removal/installation tools and reamers for each specific bushing. Tools consist of housings, guides, bolts, nuts, sleeves, and washers used in removal and installation of bushings. Tools are made to fit within confines of surrounding structure. Reamers are made to use with each bushing application, as required.

b. If damaged bushings are found in a clevis type hinge arrangement, both bushings should be replaced, allowing in-line reaming of new bushings. Bushings are removed from housings with applicable removal tools, see figure 4. Housings and new bushings should be inspected to determine if any damage or out of tolerance conditions exist. New bushings are then premachined, if required, per figure 2 and pressed into housing using appropriate installation tools, see figure 4. Tools are also used to remove/install first and second oversize replacement bushings. Most bushings must be reamed to final size, see figure 3.

c. Housing bores are drilled and reamed in-line during manufacture and are concentric to each other within a very close tolerance. During bushing manufacture, concentricity control exists between its inside and outside diameters. These conditions allow correct centerline alignment between installed bushings and allows use of piloted reamers. Compressed inside diameter of installed bushing is predictable. Pilots on reamers are machined to fit through bushings and will serve as guides during

reaming. A separate piloted reamer is required for each bushing.

4. PROCEDURES.

Support Equipment Required

None

Materials Required

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
P-D-680, TYPE 2	Dry Cleaning Solvent
TT-M-261	Methyl Ethyl Ketone
MIL-C-87962, TYPE 1	Cleaning Cloth
MIL-L-7808	Lubricating Oil
MIL-S-83430 CLB- 1/2	Sealing Compound, High Temperature
ISOPAR M	Cutting Fluid, Liquid Coolant

5. **Bushing Removal.** Tool assembly and use, see figure 4.

- a. Select correct tool assembly.

WARNING

Dry cleaning solvent and methyl ethyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

- b. Clean tool assembly with solvent moistened cloth.

- c. Install tool assembly.

WARNING

Lubricating oil contains materials hazardous to health and produces paralysis if swallowed. Prolonged contact may irritate skin. Wash hands thoroughly after handling. Use in a well ventilated area. Lubricating oil may burn if exposed to heat or flame.

- d. Lubricate threaded tools.

e. Remove bushing by turning nut with wrench. Bushing will come out into cup part of tool assembly.

- f. Disassemble tool assembly, wipe clean, and store.

6. **Inspection.** Inspect hinge half hole(s) for defects, refer to specific procedure work package.

7. **Bushing Installation.** Tool assembly and use, see figure 4.

- a. Prepare hole(s) in hinge half for replacement bushing, as required, refer to specific procedure work package.

- b. Select correct bushing for replacement, see figure 1 and specific procedure work package. Premachine bushing I.D., if required, to specific size indicated in figure 2.

WARNING

Dry cleaning solvent and methyl ethyl ketone are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

- c. Clean hole(s) in hinge half and clean bushing with solvent moistened cloth to remove contamination and foreign material.

- d. Select correct tool assembly.

WARNING

e. Clean tool assembly with solvent moistened cloth to make sure tool assembly is free of contamination or foreign material.

WARNING

Sealing compound is flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

f. Using care, apply sealing compound to OD of bushing(s) and to hinge half hole(s).

g. Install tool assembly and bushing into the hinge half hole.

WARNING

Lubricating oil contains materials hazardous to health and produces paralysis if swallowed. Prolonged contact may irritate skin. Wash hands thoroughly after handling. Use in a well ventilated area. Lubricating oil may burn if exposed to heat or flame.

h. Lubricate threaded tools with lubricating oil.

i. Bushing is installed by turning nut with wrench until bushing is seated in housing.

NOTE

Inspect bushing installation before removing tool assembly.

j. Repeat step i. if bushing is not correctly seated in hinge half.

k. Disassemble tool assembly, wipe clean, and store.

8. **Reaming Clevis Hinges.** See figures 1, 2, and 3.

NOTE

Use best accepted practices when hand reaming bushings. During reaming operations, keep cutting surfaces well oiled, maintain slow and steady axial motion during both cutting and reamer phases, and never reverse rotation direction of reamer.

a. Select correct piloted reamer for first bushing.

b. Apply cutting fluid to bushing ID surface.

c. Install reamer through bushing.

d. Ream first bushing.

e. Select correct piloted reamer for second bushing.

f. Apply cutting fluid to bushing ID surface.

g. Install reamer through bushing.

h. Ream second bushing.

i. Re-oil reamers before storage.


PART NUMBER	NOMENCLATURE	LOCATION	BUSHING NUMBER 	REAM	QTY
74A110630-1001	TRAILING EDGE FLAP SHROUD HINGE HALF,XW56.80	ATTACHED TO INNER WING	4M43P4-007	YES	1
74A110631-1001	TRAILING EDGE FLAP SHROUD HINGE HALF,XW117.293	ATTACHED TO INNER WING	4M43P4-007	YES	1
74A110705-1001	TRAILING EDGE FLAP SHROUD HINGE HALF,XW84.498	ATTACHED TO INNER WING	4M43P4-007	YES	1
74A110958-1001	TRAILING EDGE FLAP OUTBOARD HINGE HALF ASSEMBLY	ATTACHED TO INNER WING	4M43C10-011 74A110950-2013	YES YES	1 1
74A110959-1001	TRAILING EDGE FLAP INBOARD HINGE SUPPORT ASSEMBLY	ATTACHED TO INNER WING	74A110950-2009 4M43C16-015	YES YES	1 1
74A150678-1001	OUTBOARD LEADING EDGE FLAP,INBOARD HINGE HALF ASSEMBLY	ATTACHED TO OUTER WING	ST4M139BC6-14 ST4M139BC8-18 ST4M130-06013	YES YES YES	1 1 1
74A150679-1001	OUTBOARD LEADING EDGE FLAP,OUTBOARD HINGE HALF ASSEMBLY	ATTACHED TO OUTER WING	ST4M139BC6-25 ST4M139BC8-25 ST4M130-06014 ST4M130-08012	YES YES YES YES	1 1 1 1
74A150821-1001	AILERON SUPPORT INBOARD HINGE HALF ASSEMBLY	ATTACHED TO OUTER WING	74A150739-2004 ST4M139C13-60 4M43C13-010 74A150739-2003 74A150739-2005 74A150758-2003 74A150859-2001	YES YES YES YES YES YES YES	1 1 1 1 1 1 1
74A150830-1001	AILERON,OUTBOARD SUPPORT, HINGE HALF ASSEMBLY	ATTACHED TO OUTER WING	74A150859-2003 4M43C8-005	NO YES	2 1
74A170604-1007	AILERON RIB ASSEMBLY DRIVE HINGE,INBOARD	ATTACHED TO AILERON	74A170051-2001 ST4M130-12014 ST4M130-12014	YES YES YES	1 1 1
74A180684-1001	TRAILING EDGE FLAP RIB ASSEMBLY,DRIVE HINGE	ATTACHED TO TRAILING EDGE FLAP	ST4M139BC16-34 ST4M192BC12-34	YES YES	1 1
74A332130-1001 -1002	SUPPORT STRUCTURAL COM- PONENT,AIRCRAFT SPEED BRAKE ATTACH	ATTACHED TO AFT FUSELAGE	NAS75-10-029 4M45-8-47 NAS77-8-47 NAS75-10-029	NO YES YES NO	1 2 2 2

Figure 1. Hinge Points and Related Bushings (Sheet 1)



PART NUMBER	NOMENCLATURE	LOCATION	BUSHING NUMBER 	REAM	QTY
74A360001-1013 -1015	SPEED BRAKE ASSEMBLY	ATTACHED TO AFT FUSELAGE	74A360001-2025	YES	1
74A110964	TRAILING EDGE FLAP ACTUATOR,SUPPORT ASSEMBLY	ATTACHED TO INNER WING	ST4M192C12-48 ST4M139BC16-48	YES YES	1 1
74A180698-1001	TRAILING EDGE FLAP SHROUD,SPAR ASSEMBLY	ATTACHED TO SHROUD	ST4M130-04014 ST4M130-04027	NO NO	2 2
74A110955	TRAILING EDGE FLAP,DEFLECTION LIMITING SUPPORT ASSEMBLY	ATTACHED TO INNER WING	ST4M130-04014	NO	2
74A180754	TRAILING EDGE FLAP SHROUD, OUTBOARD CLOSURE RIB	ATTACHED TO TRAILING EDGE FLAP SHROUD	4M43P4-009	NO	1
74A150811-1001 74A150853-1001 74A150828-1001 74A150829-1001 74A150831-1001 74A150833-1001	AILERON SHROUD HINGE HALF ASSEMBLY: SUPPORT NO4 XW224.250 XW174.750 XW199.400 XW188.700 XW216.000	ATTACHED TO OUTER WING	NAS76A3-006 NAS76A3-006 NAS76A3-006 NAS76A3-006 NAS76A3-006 NAS76A3-006	NO NO NO NO NO NO	1 1 1 1 1 1
74A170103	AILERON SHROUD ASSEMBLY	ATTACHED TO AILERON	ST4M130-03010	NO	12
74A180746	INBOARD FLAP	ATTACHED TO LEADING EDGE INBOARD WING	ST4M130-05022 ST4M139BC5-38	YES YES	1 1
<p style="text-align: center;">LEGEND</p> <p> BUSHINGS MAY HAVE LIMITED EFFECTIVITY, REFER TO SPECIFIC PROCEDURE WORK PACKAGE(S).</p>					

Figure 1. Hinge Points and Related Bushings (Sheet 2)







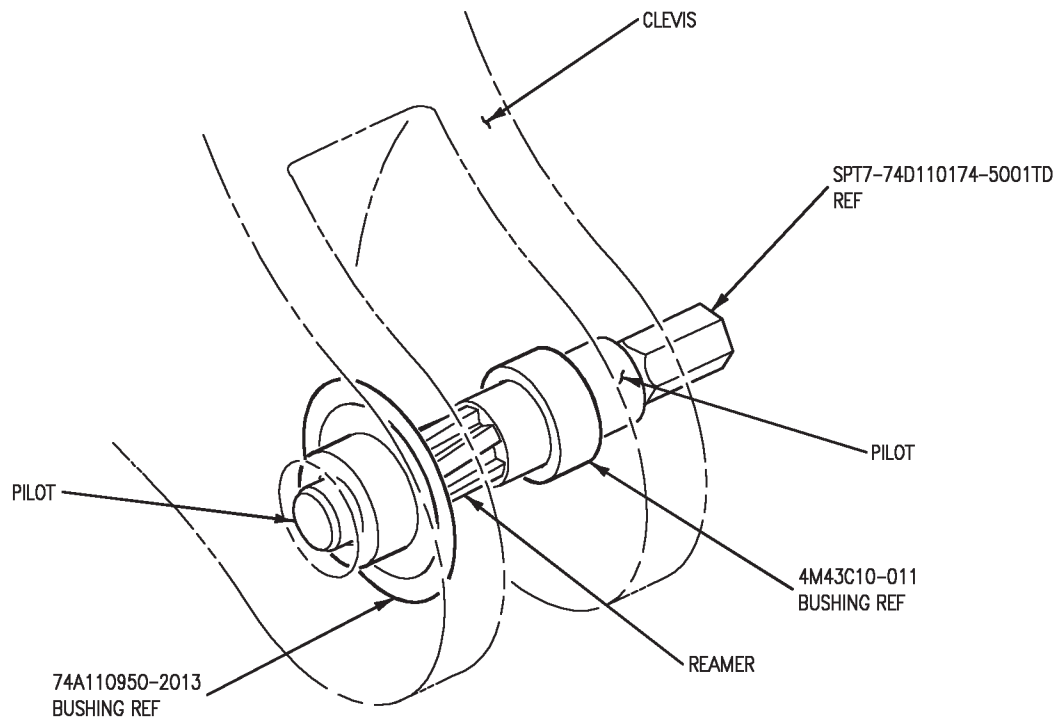
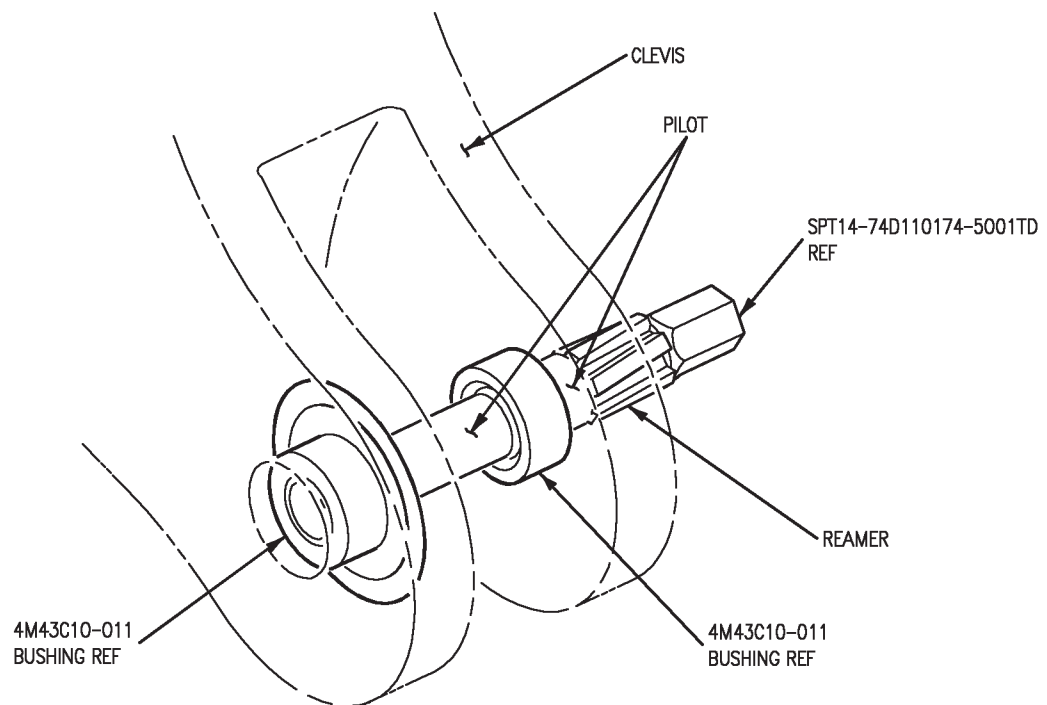
BUSHING NUMBER 	PREPARED BUSHING  	FINISH REAMER NUMBER
ST4M139BC8-18(2)	0.497	SPT8-74D110174-5001TD
ST4M139BC8-25(2)	0.497	SPT8-74D110174-5001TD
ST4M130-08012(2)	0.497	SPT8-74D110174-5001TD
ST4M139BC6-14(1)	0.371	SPT2-74D110174-5001TD
ST4M139BC6-25(1)	0.371	SPT2-74D110174-5001TD
ST4M130-06013(1)	0.371	SPT2-74D110174-5001TD
ST4M130-06014(1)	0.371	SPT2-74D110174-5001TD
74A150739-2003(1)	0.621	SPT3-74D110174-5001TD
74A150739-2004(1)	0.621	SPT3-74D110174-5001TD
74A150739-2005(1)	0.621	SPT3-74D110174-5001TD
4M43P4-007	0.257	-
4M43P4-009	0.257	-
74A360001-2025(1)	0.746	SPT17-74D110174-5001TD
4M45-8-47(1)	0.496	SPT16-74D110174-5001TD
4M43C10-011(2)	0.621	SPT14-74D110174-5001TD
74A110950-2013(1)	0.496	SPT7-74D110174-5001TD
ST4M192C12-48(1)	0.746	SPT18-74D110174-5001TD
ST4M192BC12-34(1)	0.746	SPT6-74D110174-5001TD
4M43C8-005(2)	0.498	SPT15-74D110174-5001TD
ST4M139BC16-48(2)	0.996	SPT19-74D110174-5001TD
74B170051-2001(1)	0.621	SPT4-74D110174-5001TD
ST4M130-10017(1)	0.621	SPT4-74D110174-5001TD
ST4M139BC16-34(2)	0.996	SPT13-74D110174-5001TD
4M43C13-010(2)	0.811	SPT10-74D110174-5001TD
ST4M130-12014(2)	0.808	SPT11-74D110174-5001TD
4M43C16-015(2)	0.996	SPT12-74D110174-5001TD
74A110950-2009(1)	0.871	SPT5-74D110174-5001TD
ST4M139C13-60(2)	0.808	SPT9-74D110174-5001TD
ST4M130-05022(1)	0.309	SPT20-74D110174-5001TD
ST4M139BC5-38(2)	0.309	SPT22-74D110174-5001TD
<p style="text-align: center;">LEGEND</p> <p> NUMBER IN PARENTHESES INDICATES SEQUENCE FOR INSTALLATION IN CLEVIS TYPE HINGE.</p> <p> ID TO REMAIN PARALLEL TO OD AND CONCENTRIC WITHIN 0.003.</p> <p> ID + 0.001 -0.001.</p>		

Figure 2. Bushings and Related Reamers



TYPICAL ARRANGEMENT FOR HAND
REAMING A DOUBLE BUSHING CLEVIS
FIRST BUSHING



TYPICAL ARRANGEMENT FOR HAND
REAMING A DOUBLE BUSHING CLEVIS

SECOND BUSHING

Figure 3. Typical Reaming Setup

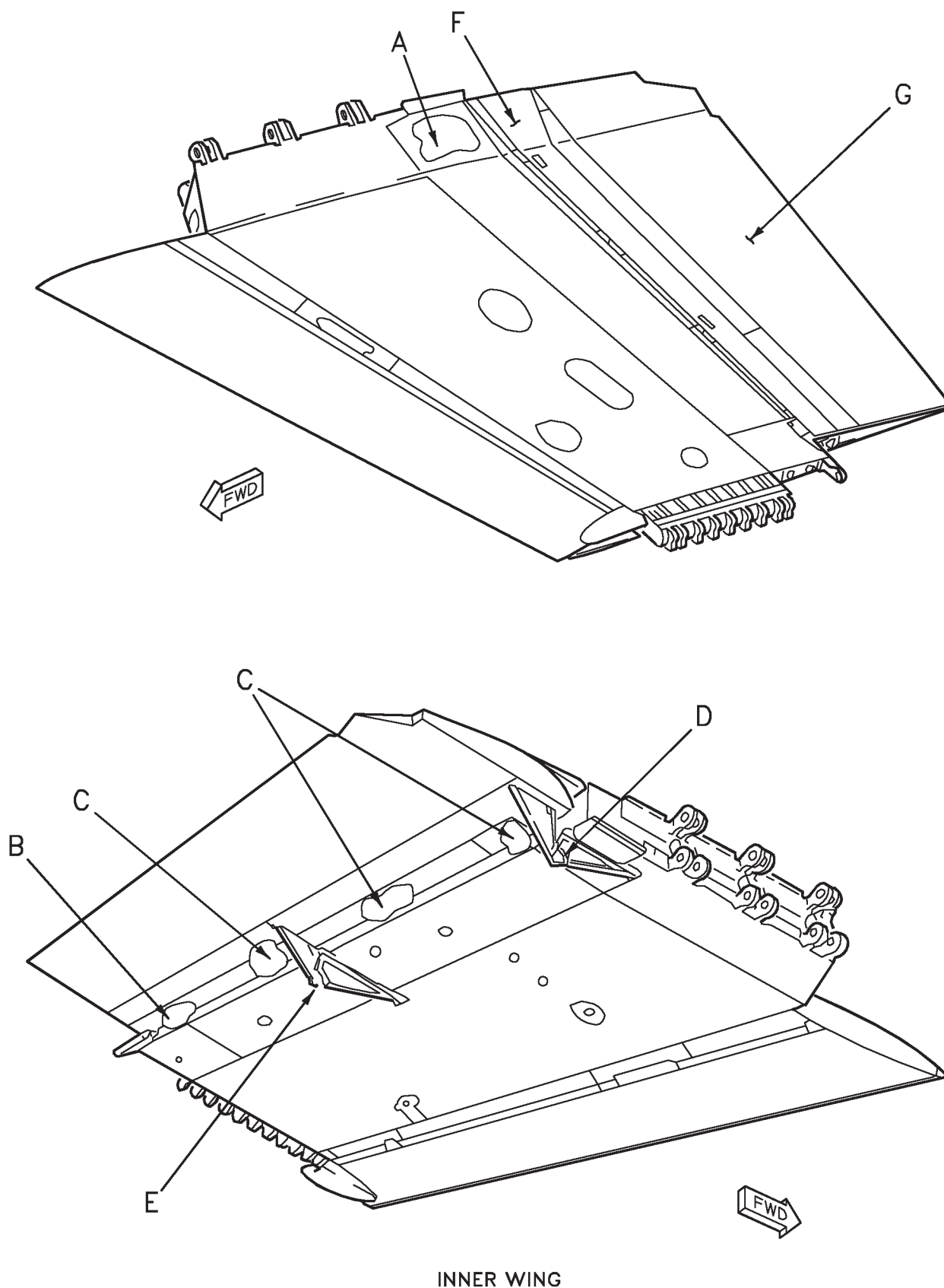
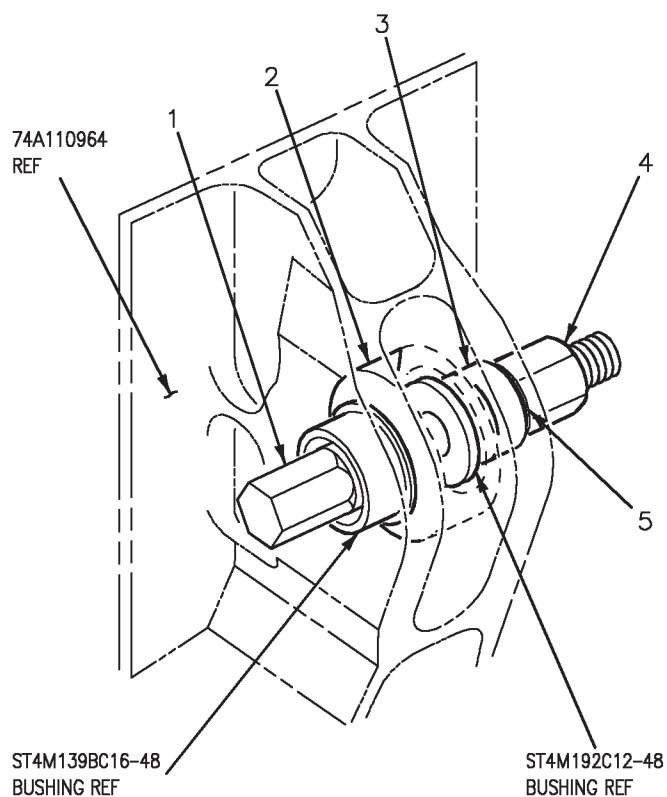
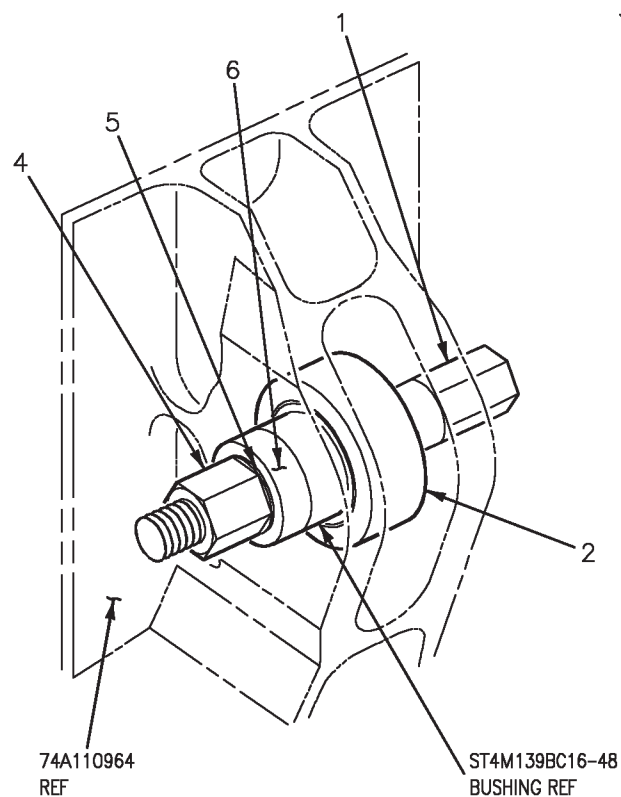


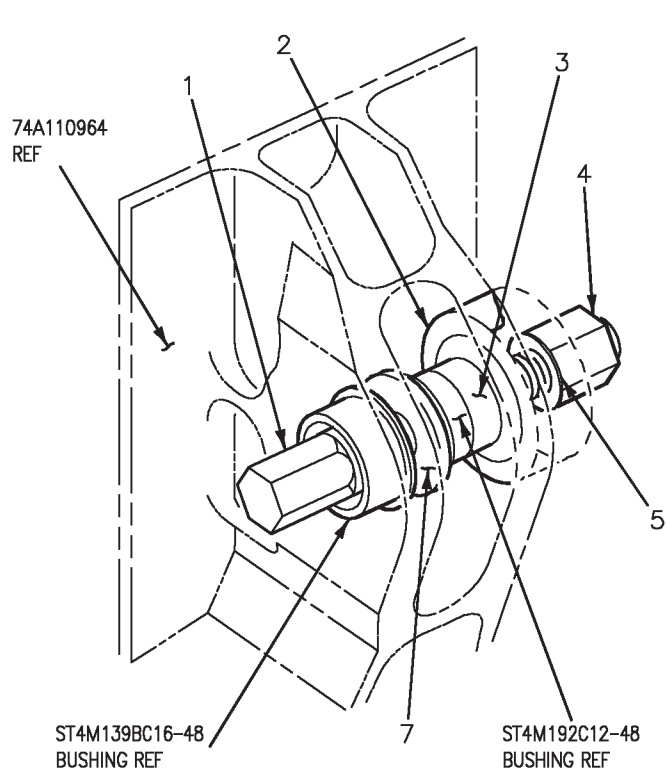
Figure 4. Bushing Removal, Installation, and Reaming (Sheet 1)



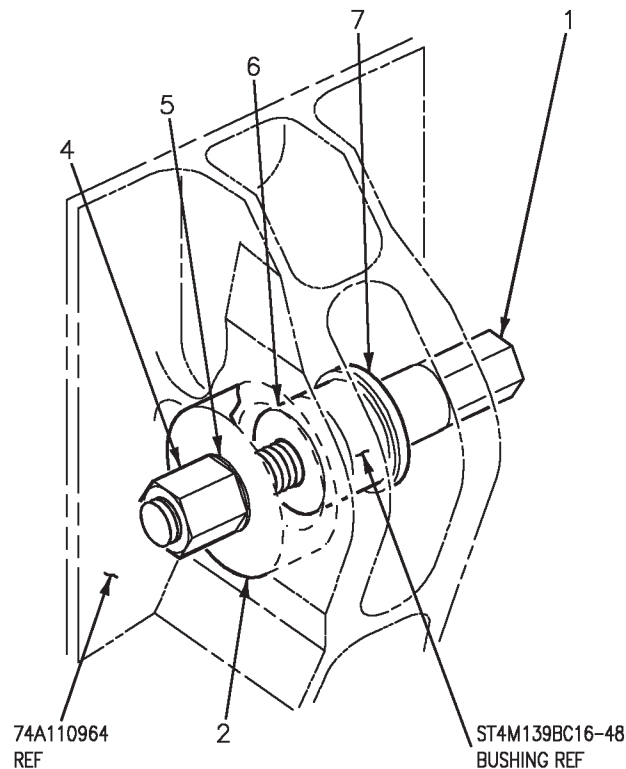
REMOVAL
STEP 1



REMOVAL
STEP 2



INSTALLATION
STEP 4



INSTALLATION
STEP 3

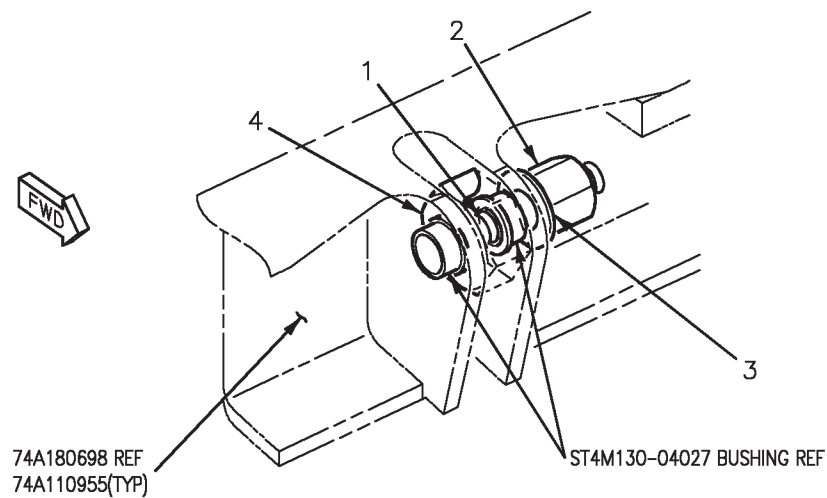
A

Figure 4. Bushing Removal, Installation, and Reaming (Sheet 2)

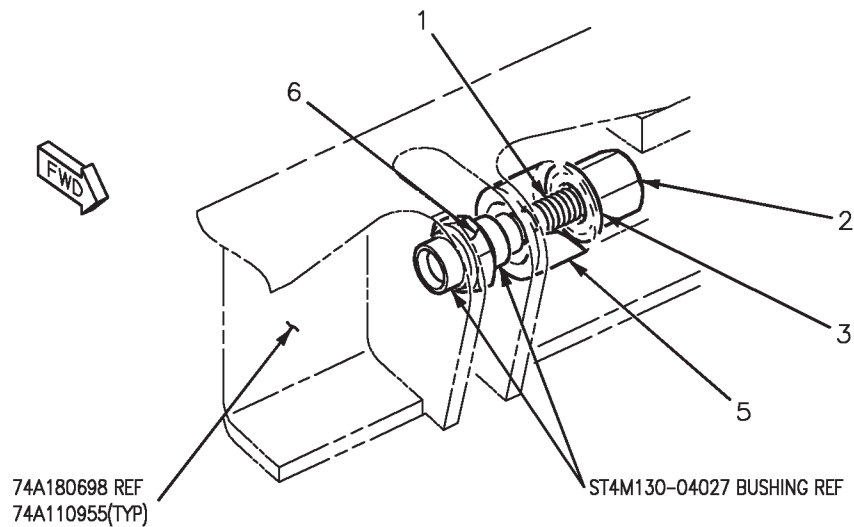
A CONT.

INDEX NO.	PART NUMBER	DESCRIPTION	USE
1	74D111355-2027	BOLT	REM/INST
2	74D111355-2043	HOUSING	REM/INST
3	74D111355-2045	GUIDE	REM/INST
4	74D111355-2029	NUT	REM/INST
5	AN960-816	WASHER	REM/INST
6	74D111355-2033	GUIDE	REM/INST
7	74D111355-2057	WASHER	INST
LEGEND			
1. REMOVAL AND INSTALLATION OF ST4M192C12-48 AND ST4M139BC16-48 BUSHINGS ON 74A110964 CLEVIS.			

Figure 4. Bushing Removal, Installation, and Reaming (Sheet 3)



REMOVAL



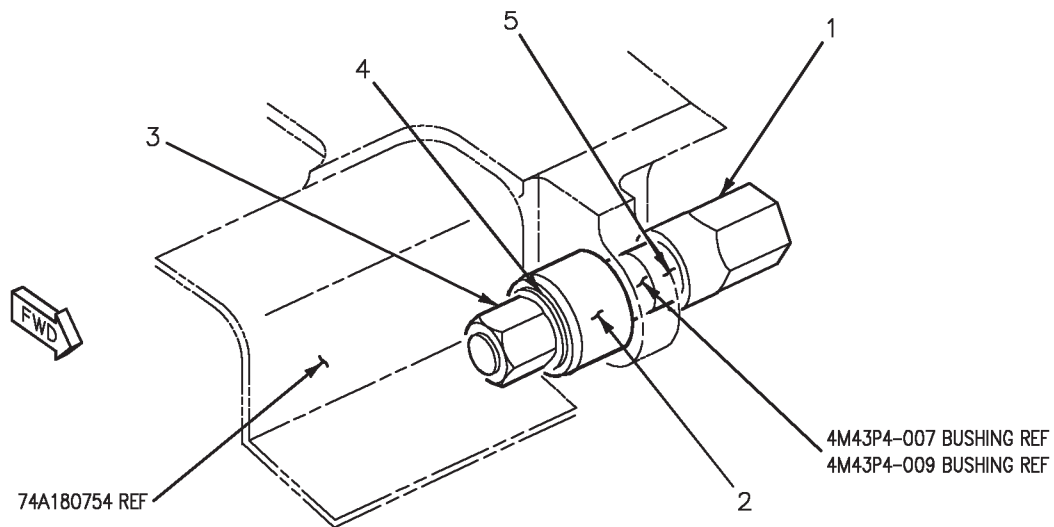
INSTALLATION

B

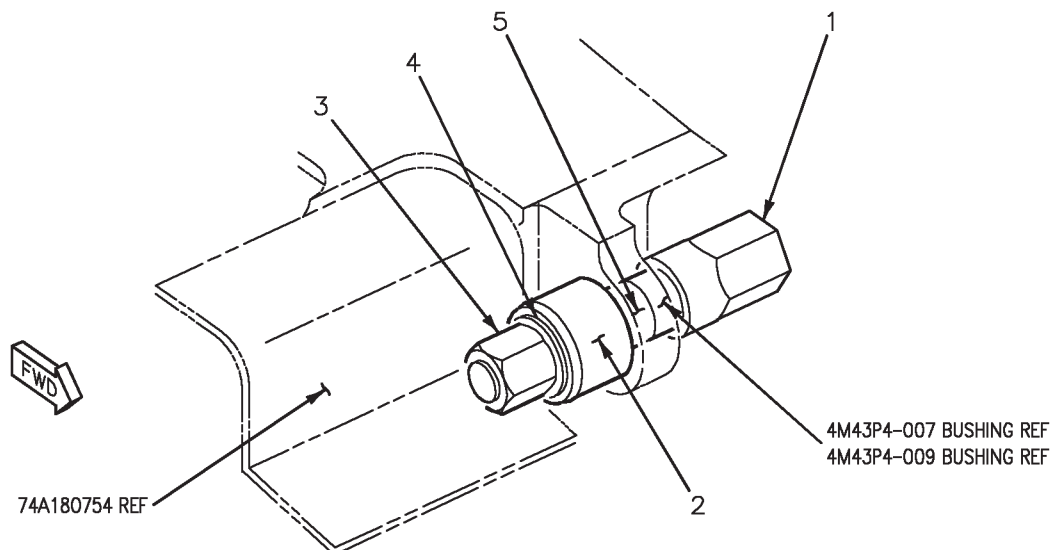
INDEX NO.	PART NUMBER	NOMENCLATURE	USE
1	74D111355-2103A	PIN	REM/INST
2	74D111355-2007A	NUT	REM/INST
3	AN960-416	WASHER	REM/INST
4	74D111355-2101A	HOUSING	REM
5	74D111355-2099A	HOUSING	INST
6	AN316-4R	NUT	INST

LEGEND			
1.	REMOVAL AND INSTALLATION OF ST4M130-04014 AND ST4M130-04027 BUSHINGS ON 74A180698 CLEVIS.		
2.	TYPICAL FOR REMOVAL AND INSTALLATION OF ST4M130-04014 BUSHING ON 74A110955 CLEVIS.		

Figure 4. Bushing Removal, Installation, and Reaming (Sheet 4)



REMOVAL



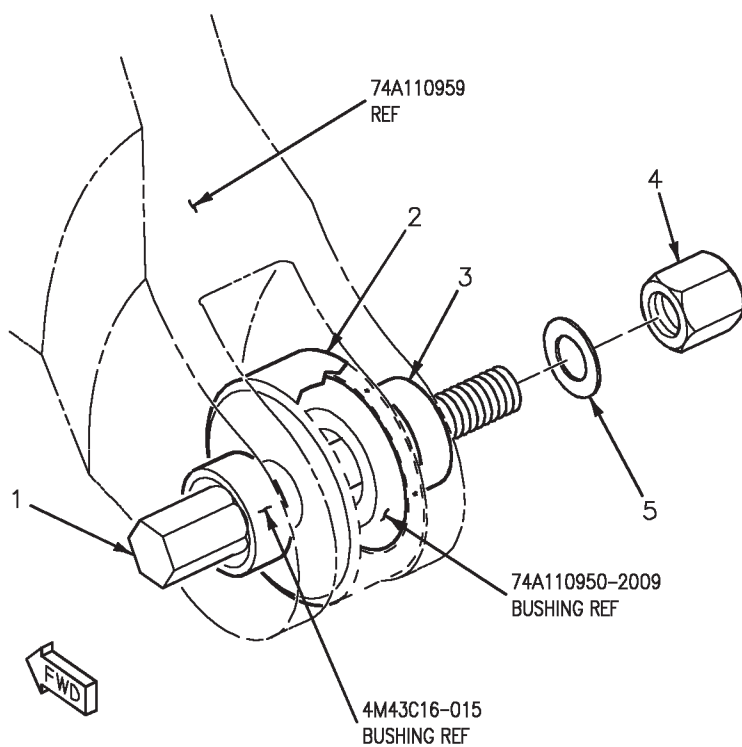
INSTALLATION

C

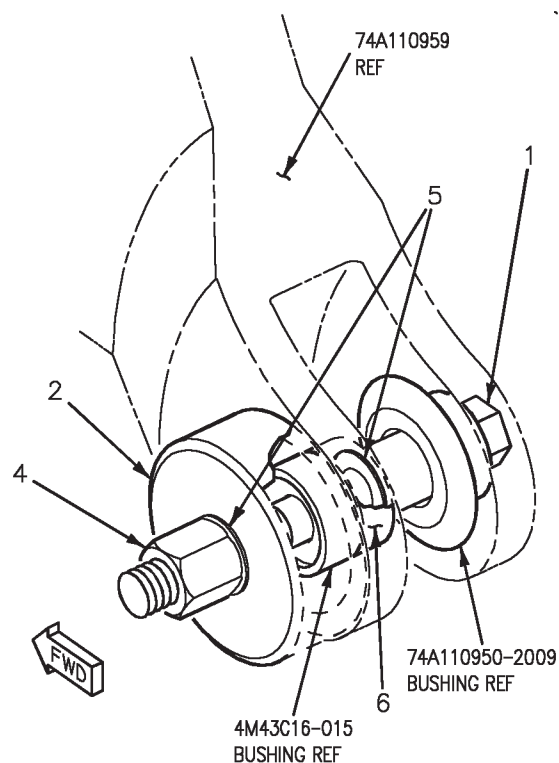
INDEX NO.	PART NUMBER	NOMENCLATURE	USE
1	74D111355-2005	PIN	REM/INST
2	74D111355-2001	HOUSING	REM/INST
3	74D111355-2007A	NUT	REM/INST
4	AN960-416	WASHER	REM/INST
5	74D111355-2009	SLEEVE	REM/INST

LEGEND			
1.	REMOVAL AND INSTALLATION OF 4M43P4-007 BUSHING ON 74A110630, 74A110631, AND 74A110705 LUG.		
2.	TYPICAL FOR REMOVAL AND INSTALLATION OF 4M43P4-009 BUSHING ON 74A180754 LUG.		

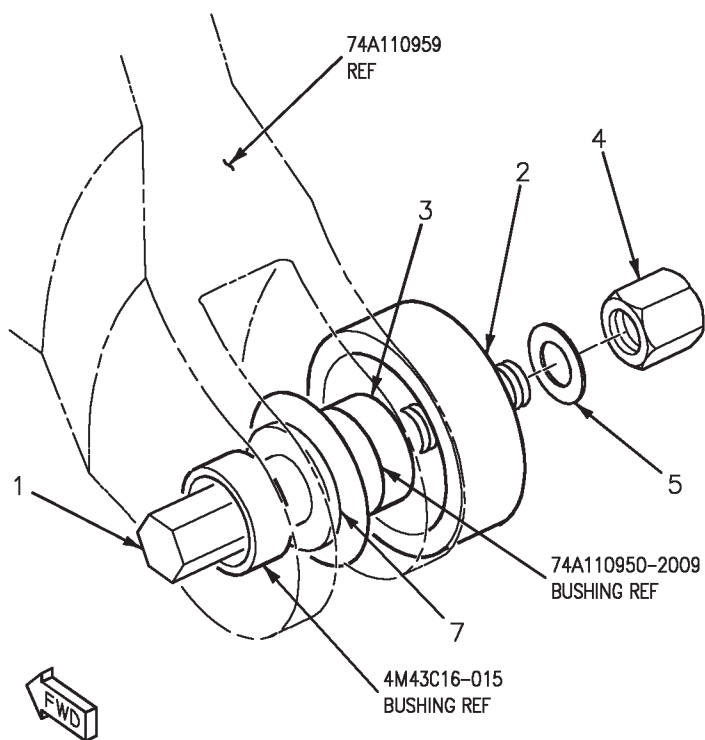
Figure 4. Bushing Removal, Installation, and Reaming (Sheet 5)



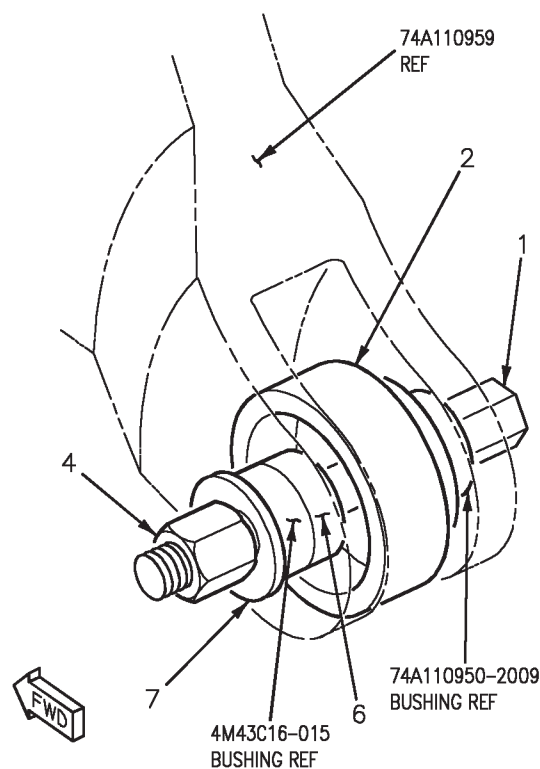
REMOVAL



REMOVAL



INSTALLATION



INSTALLATION

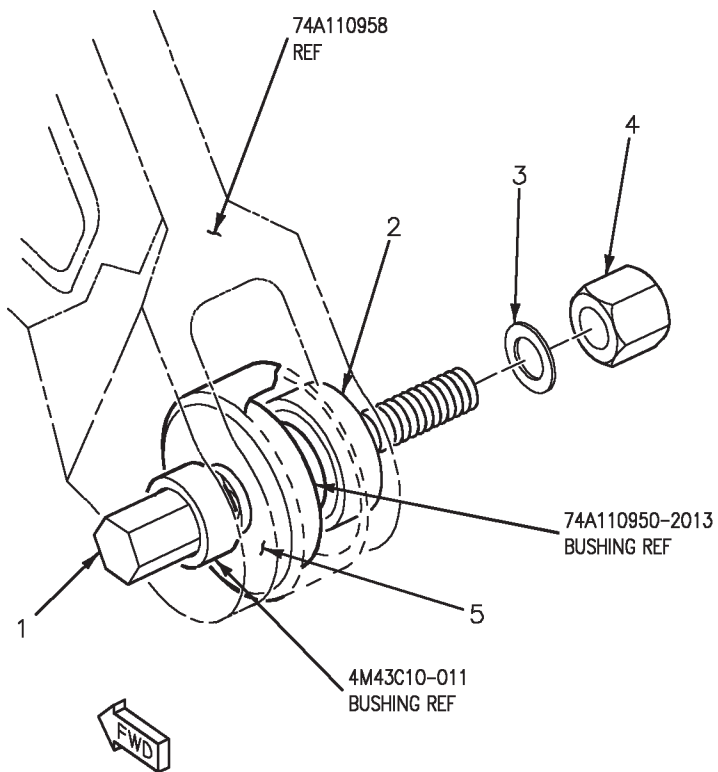
D

Figure 4. Bushing Removal, Installation, and Reaming (Sheet 6)

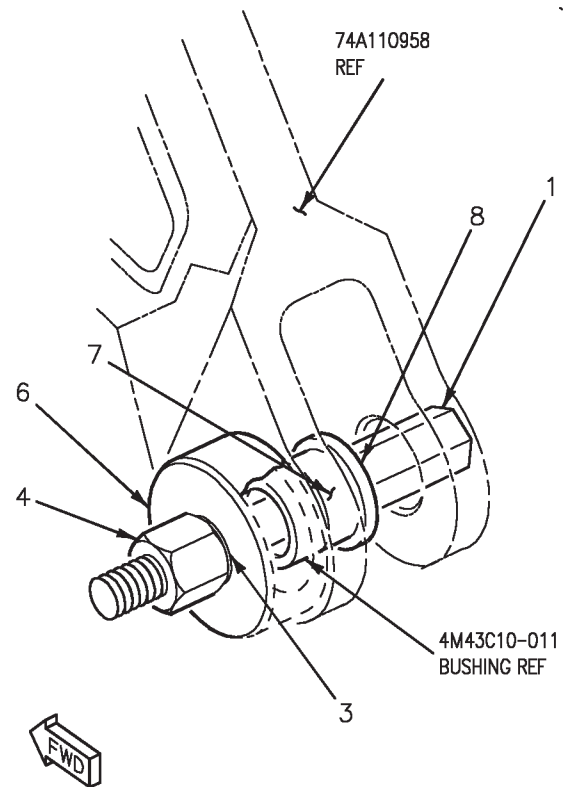
D CONT.

INDEX NO.	PART NUMBER	NOMENCLATURE	USE
1	74D111355-2027	BOLT	REM/INST
2	74D111355-2023	HOUSING	REM/INST
3	74D111355-2025	GUIDE	REM/INST
4	74D111355-2029	NUT	REM/INST
5	AN960-816	WASHER	REM/INST
6	74D111355-2033	GUIDE	REM/INST
7	74D111355-2057	WASHER	INST
LEGEND			
1. REMOVAL AND INSTALLATION OF 74A110950-2009 AND 4M43C16-015 BUSHINGS ON 74A110959 CLEVIS.			

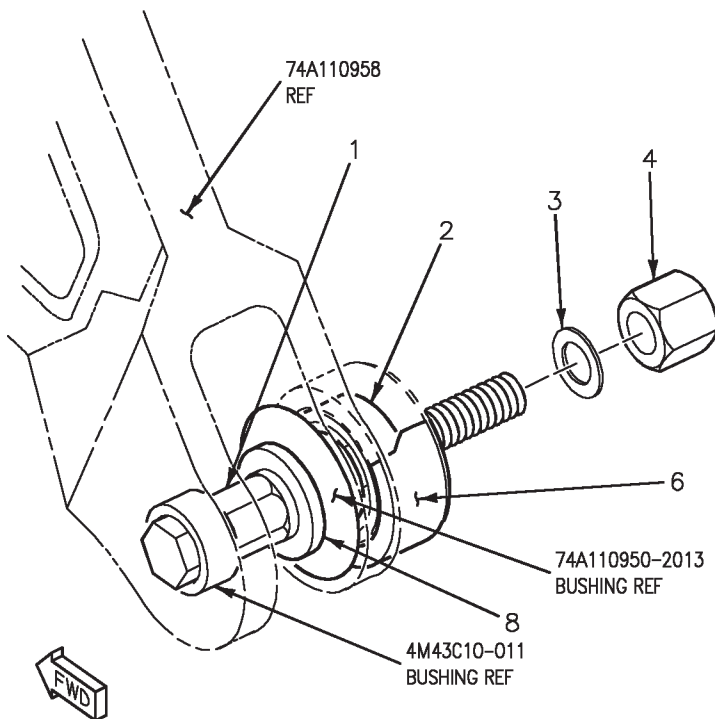
Figure 4. Bushing Removal, Installation, and Reaming (Sheet 7)



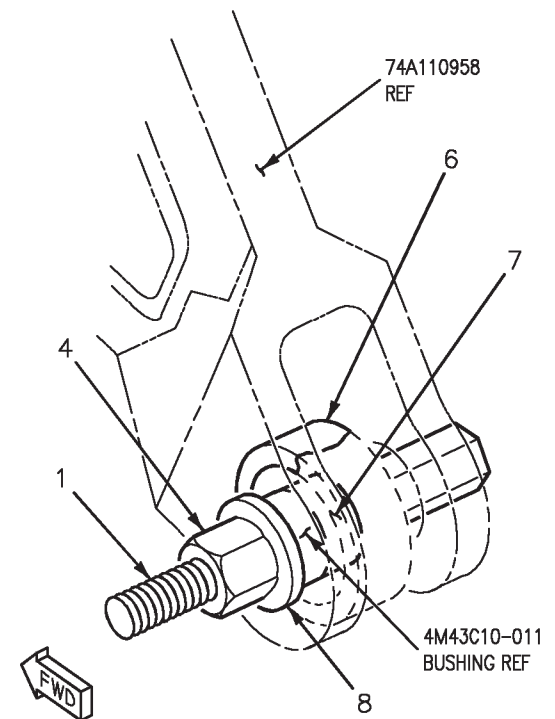
REMOVAL
STEP 1



REMOVAL
STEP 2



INSTALLATION
STEP 4



INSTALLATION
STEP 3

E

Figure 4. Bushing Removal, Installation, and Reaming (Sheet 8)

E CONT.

INDEX NO.	PART NUMBER	NOMENCLATURE	USE
1	74D111355-2015	BOLT	REM/INST
2	74D111355-2021	GUIDE	REM/INST
3	AN960-616	WASHER	REM/INST
4	74D111355-2061	NUT	REM/INST
5	74D111355-2019	HOUSING	REM
6	74D111355-2011	HOUSING	REM/INST
7	74D111355-2013	GUIDE	REM/INST
8	74D111355-2143	WASHER	INST
LEGEND			
1.	REMOVAL AND INSTALLATION OF 74A110950-2013 AND 4M43C10-011 BUSHINGS ON 74A110958 CLEVIS.		

Figure 4. Bushing Removal, Installation, and Reaming (Sheet 9)

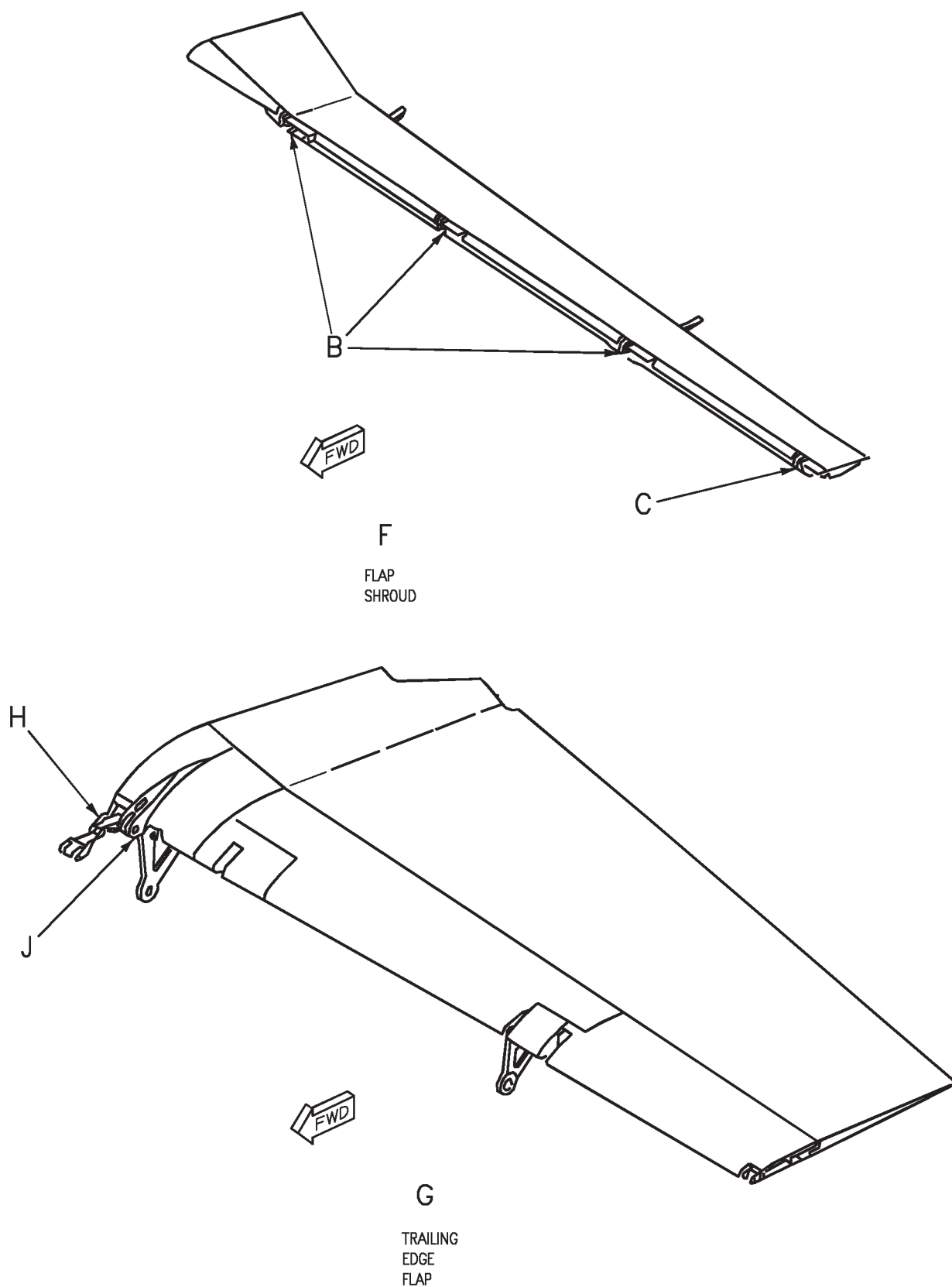
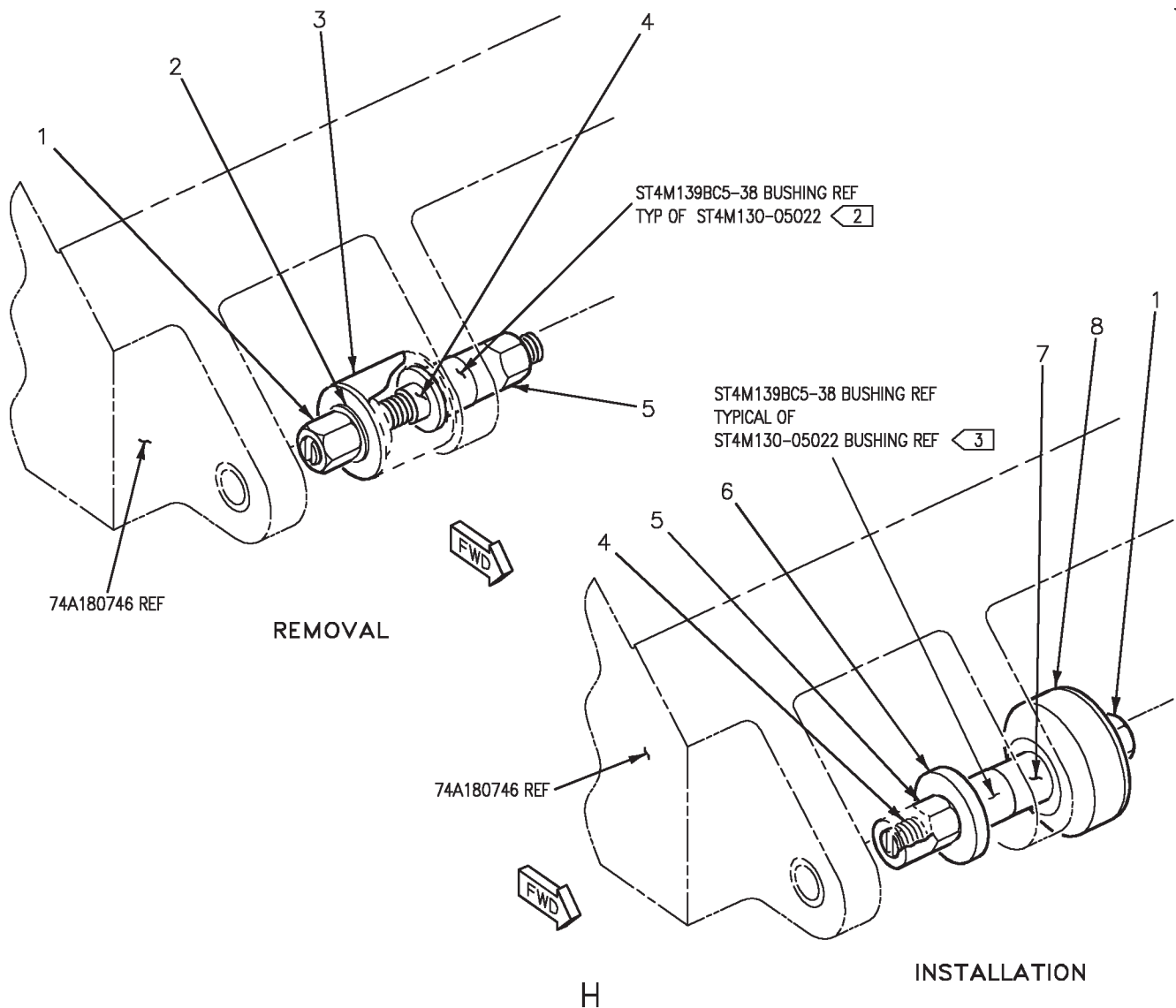


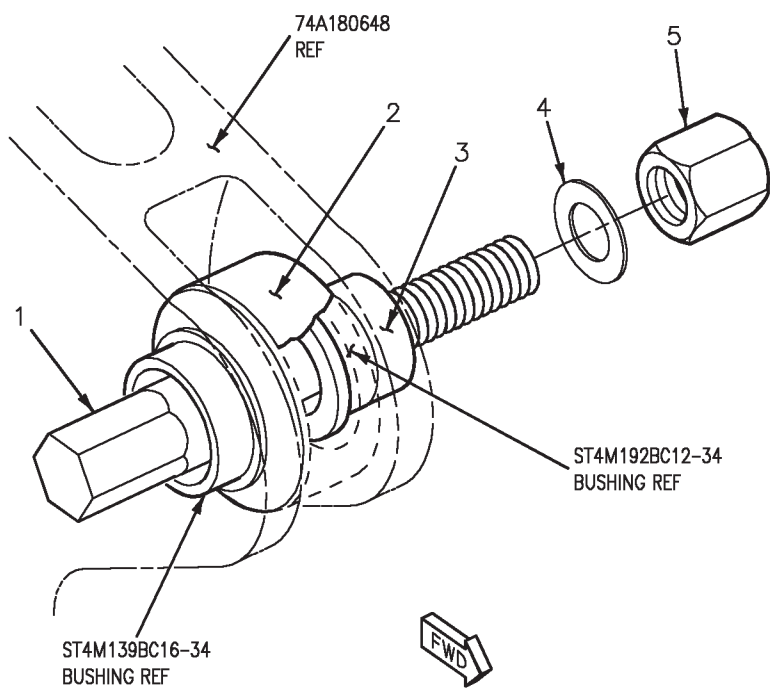
Figure 4. Bushing Removal, Installation, and Reaming (Sheet 10)



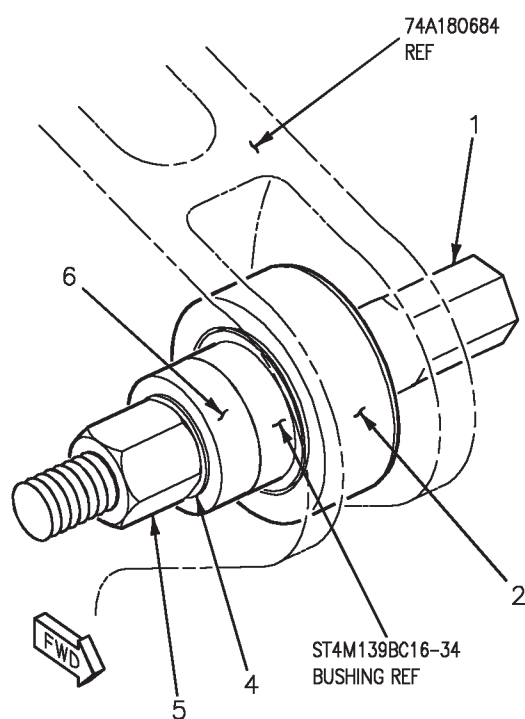
INDEX NO.	PART NUMBER	NOMENCLATURE	USE
1	74D111355-2007A	NUT	REM/INST
2	AN960-416	WASHER	REM
3	74D111355-2035	HOUSING	REM
4	74D111355-2047A	BOLT	REM/INST
5	74D111355-2105A	DRIVER	REM/INST
6	74D111355-2073	WASHER	INST
7	74D111355-2041A	SLEEVE	INST
8	74D111355-2067	HOUSING	INST

LEGEND			
1. REMOVAL AND INSTALLATION OF ST4M130-05022 AND ST4M139BC5-38 BUSHINGS ON 74A180746 LUG.			
2	REMOVE FIRST.		
3	INSTALL LAST.		

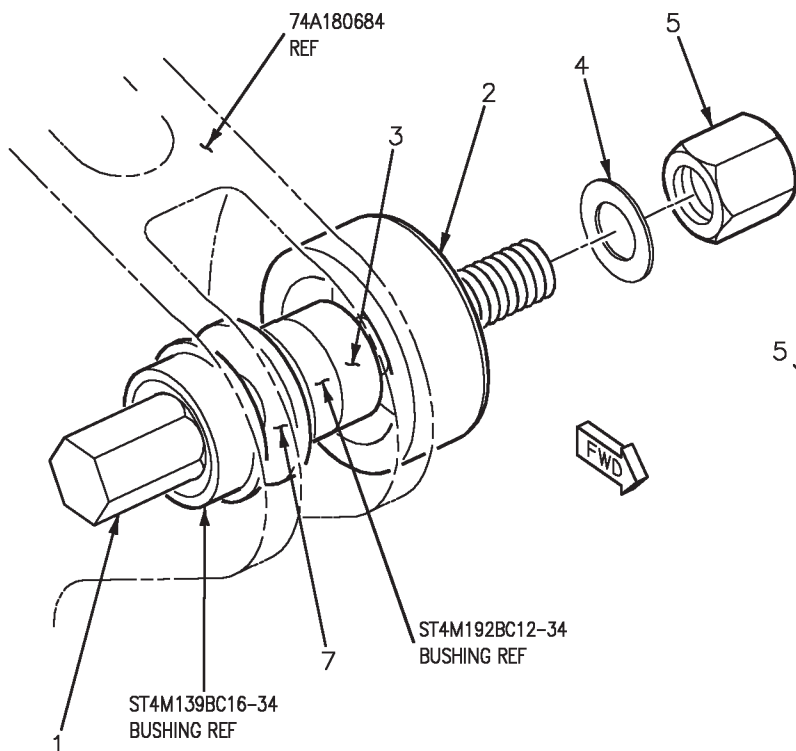
Figure 4. Bushing Removal, Installation, and Reaming (Sheet 11)



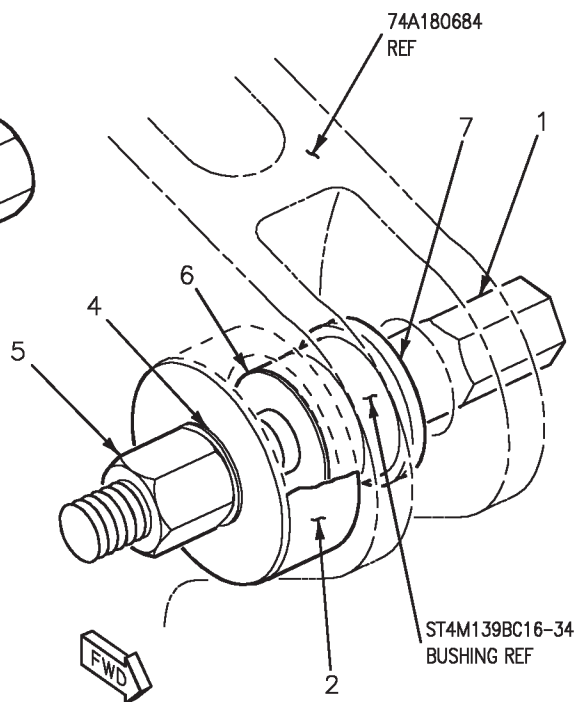
REMOVAL
STEP 1



REMOVAL
STEP 2



INSTALLATION
STEP 4



INSTALLATION
STEP 3

Figure 4. Bushing Removal, Installation, and Reaming (Sheet 12)

J CONT.

INDEX NO.	PART NUMBER	NOMENCLATURE	USE
1	74D111355-2027	BOLT	REM/INST
2	74D111355-2043	HOUSING	REM/INST
3	74D111355-2045	GUIDE	REM/INST
4	AN960-816	WASHER	REM/INST
5	74D111355-2029	NUT	REM/INST
6	74D111355-2033	GUIDE	REM/INST
7	74D111355-2057	WASHER	INST
LEGEND			
1.	REMOVAL AND INSTALLATION OF ST4M192BC12-34 AND ST4M139C16-34 BUSHINGS ON 74A180648 CLEVIS.		

Figure 4. Bushing Removal, Installation, and Reaming (Sheet 13)

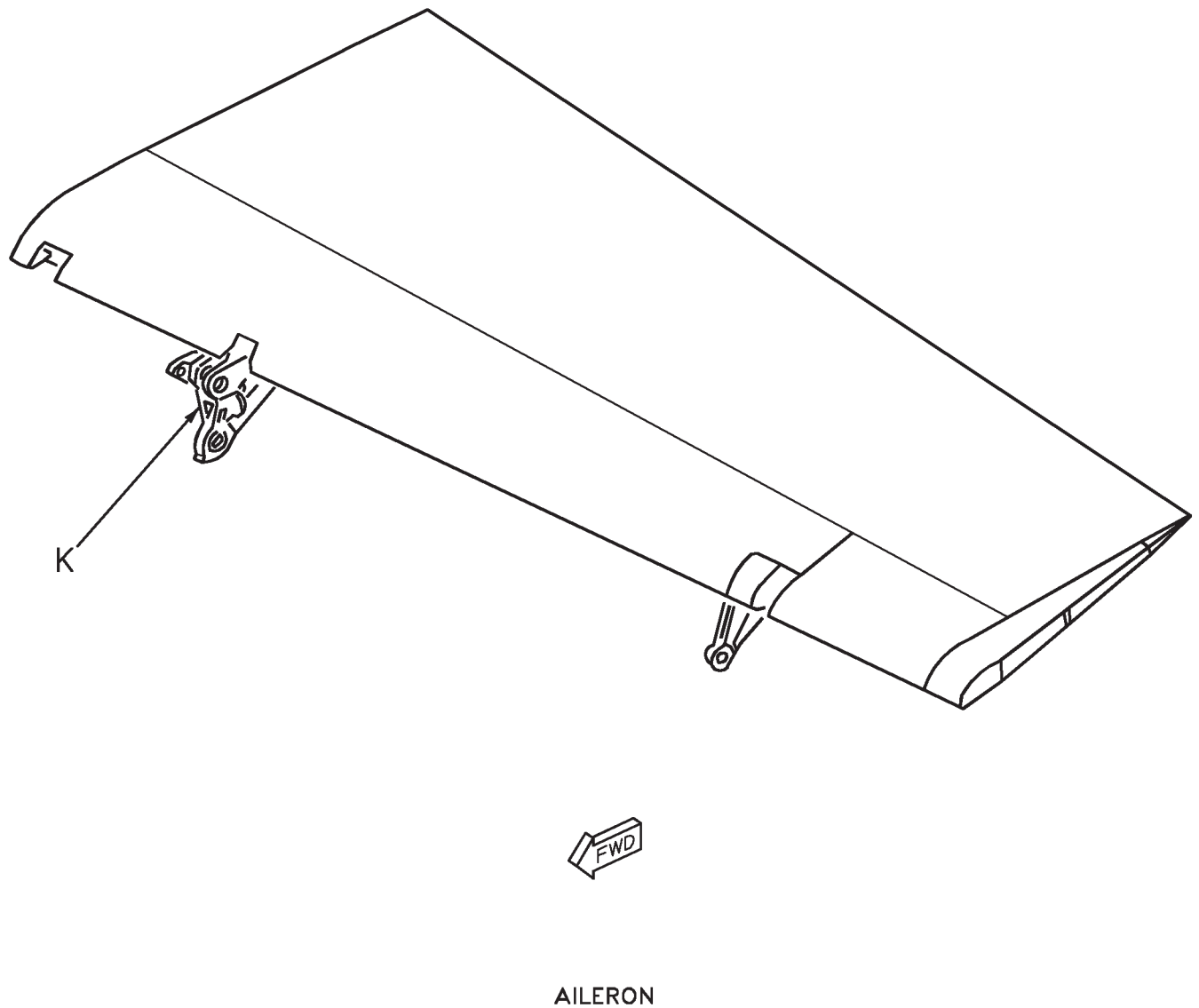
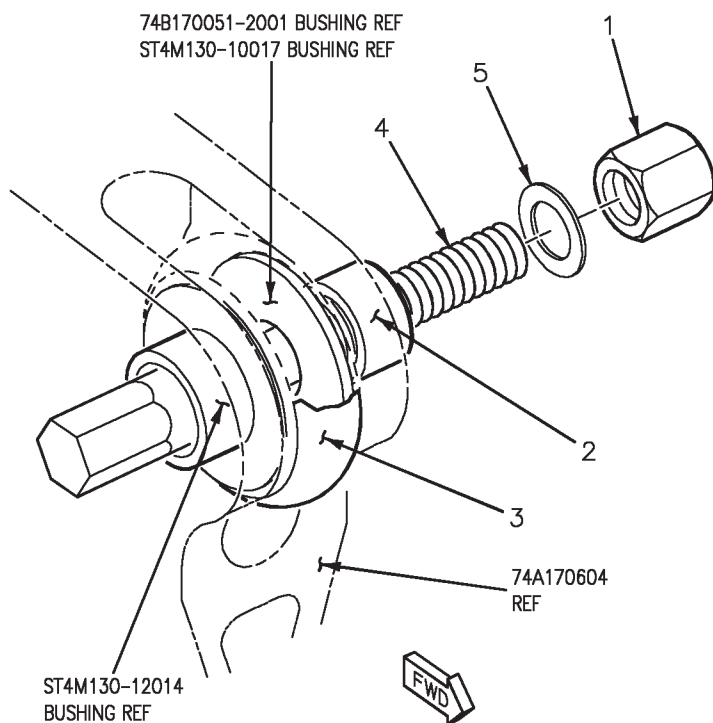
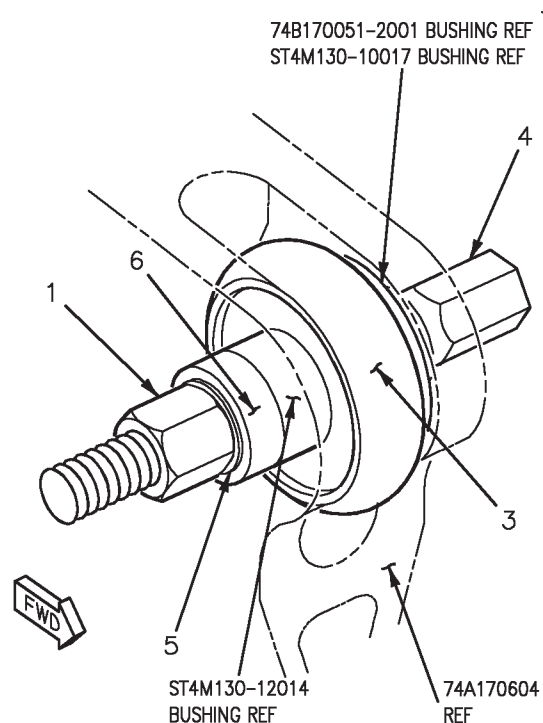


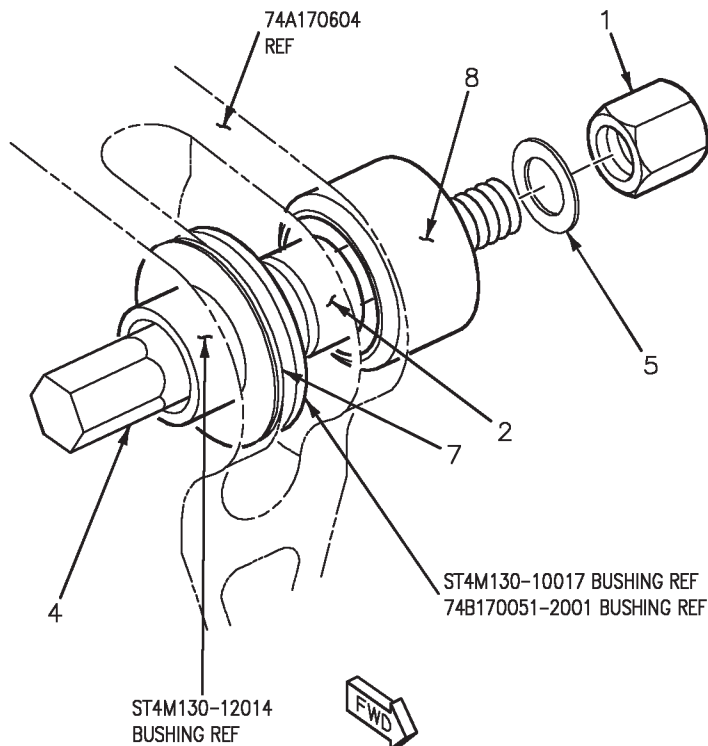
Figure 4. Bushing Removal, Installation, and Reaming (Sheet 14)



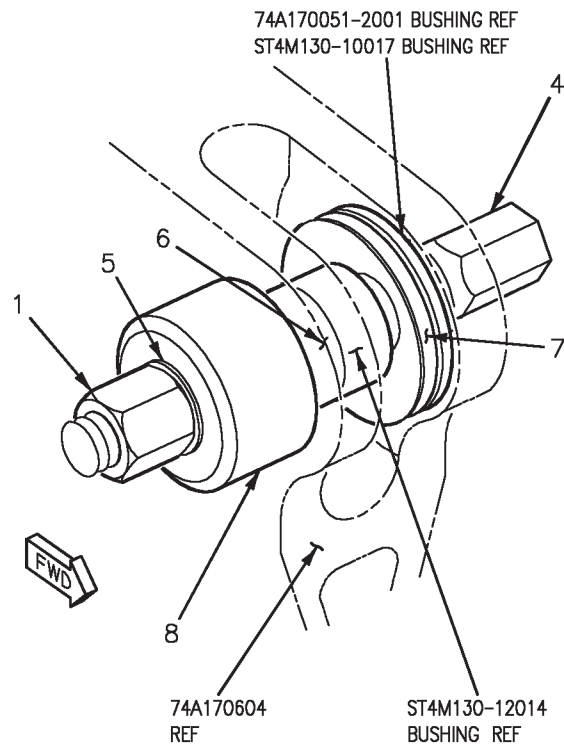
REMOVAL



REMOVAL



INSTALLATION



INSTALLATION

K

Figure 4. Bushing Removal, Installation, and Reaming (Sheet 15)

K CONT.

INDEX NO.	PART NUMBER	NOMENCLATURE	USE
1	74D111355-2131	NUT	REM/INST
2	74D111355-2079	GUIDE	REM/INST
3	74D111355-2059	HOUSING	REM
4	74D111355-2115	BOLT	REM/INST
5	AN960-716	WASHER	REM/INST
6	74D111355-2065	GUIDE	REM/INST
7	74D111355-2063	WASHER	INST
8	74D111355-2077	HOUSING	INST
LEGEND			
1. REMOVAL AND INSTALLATION OF 74B170051-2001,ST4M130-10017, AND ST4M130-12014 BUSHINGS ON 74A170604 CLEVIS.			

Figure 4. Bushing Removal, Installation, and Reaming (Sheet 16)

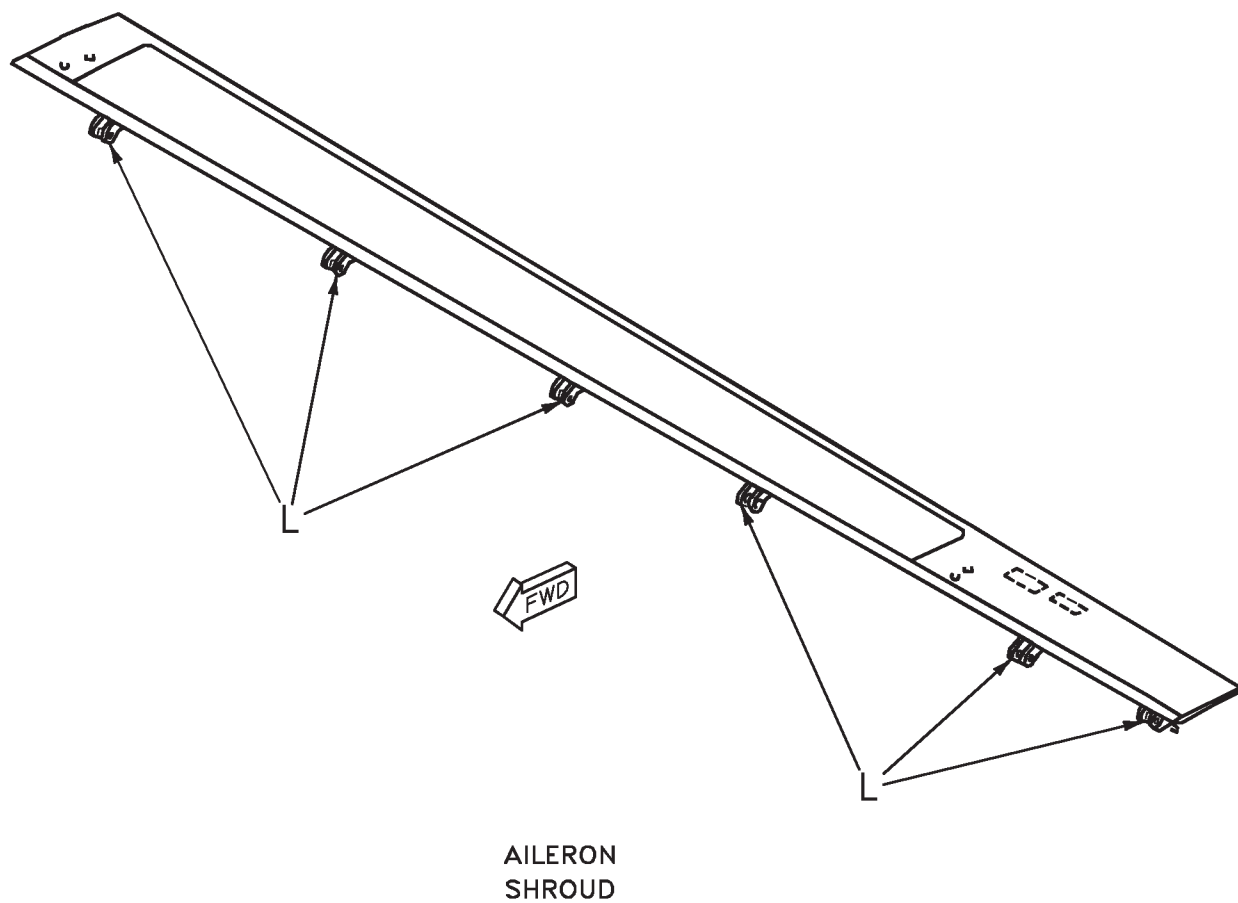
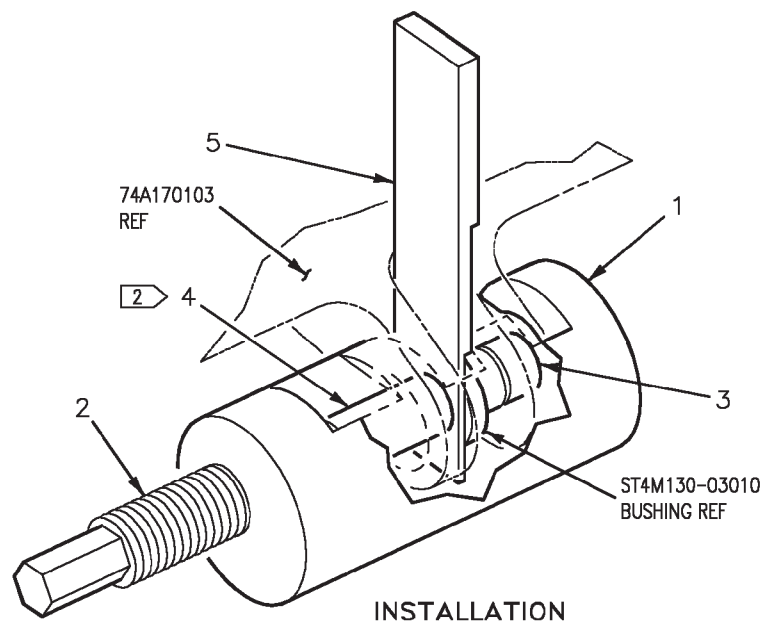
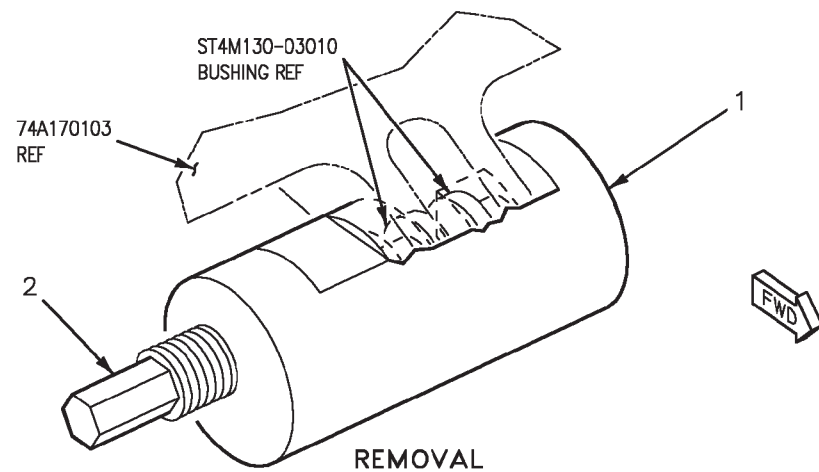


Figure 4. Bushing Removal, Installation, and Reaming (Sheet 17)



L

INDEX NO.	PART NUMBER	NOMENCLATURE	USE
1	74D111355-2117	HOUSING	REM/INST
2	74D111355-2121	PIN	REM/INST
3	74D111355-2119	GUIDE	INST
4	74D111355-2141	SLEEVE	INST
5	74D111355-2123	PLATE	INST

LEGEND			
1. REMOVAL AND INSTALLATION OF ST4M130-03010 BUSHING ON 74A170103, 6 PLACES.			
2 USED ONLY FOR FIRST BUSHING.			

Figure 4. Bushing Removal, Installation, and Reaming (Sheet 18)

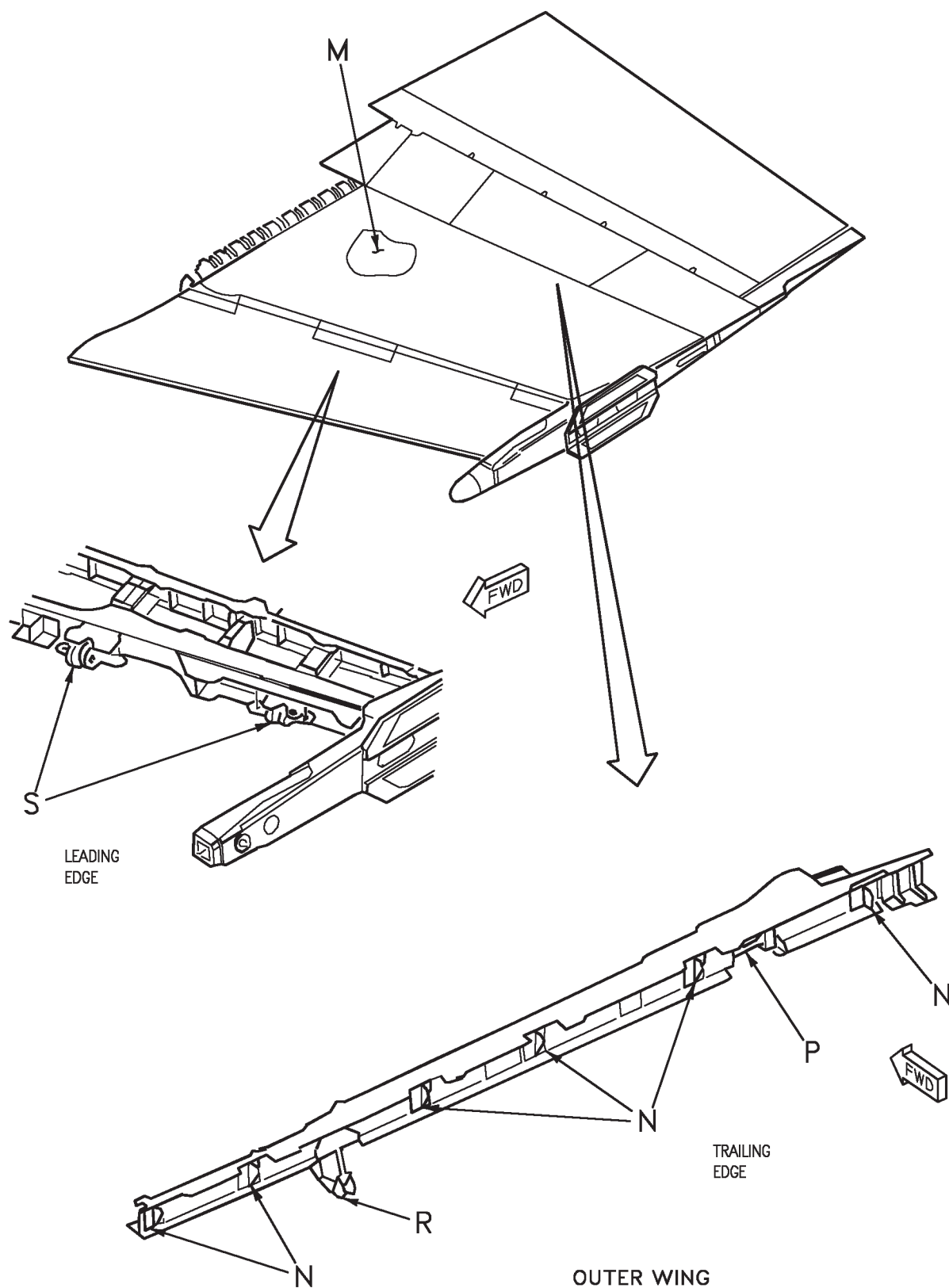
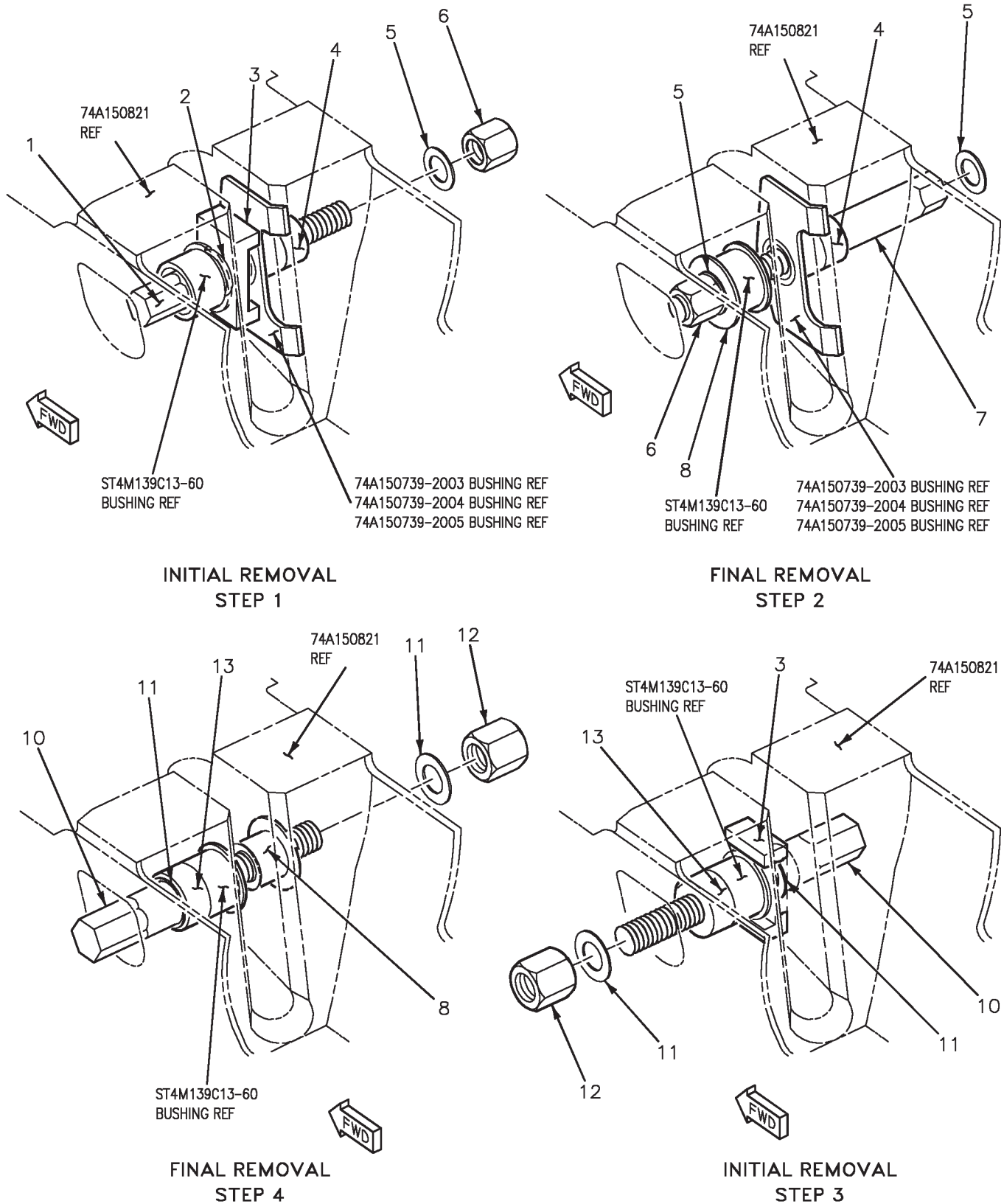
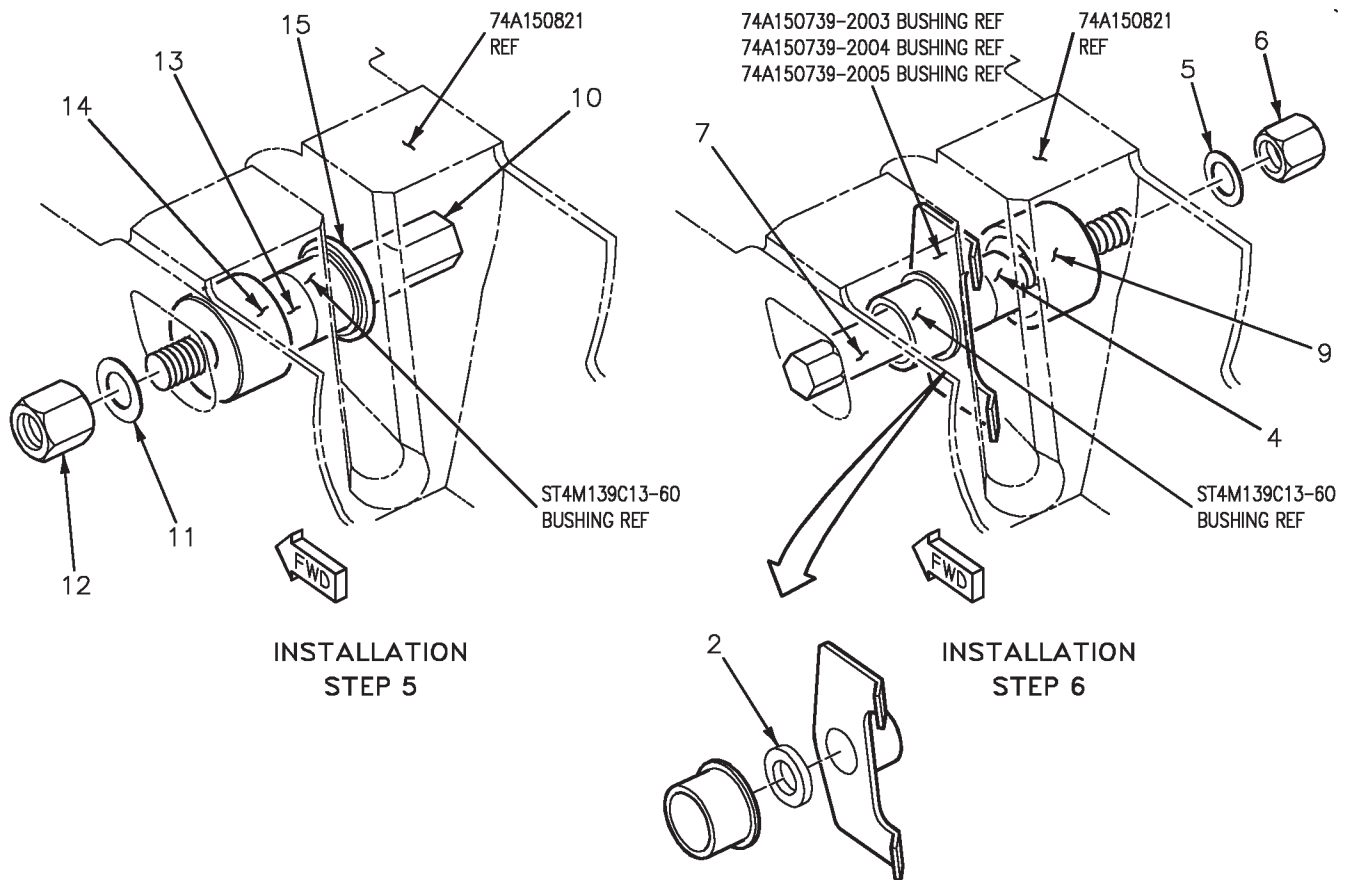


Figure 4. Bushing Removal, Installation, and Reaming (Sheet 19)



M

Figure 4. Bushing Removal, Installation, and Reaming (Sheet 20)



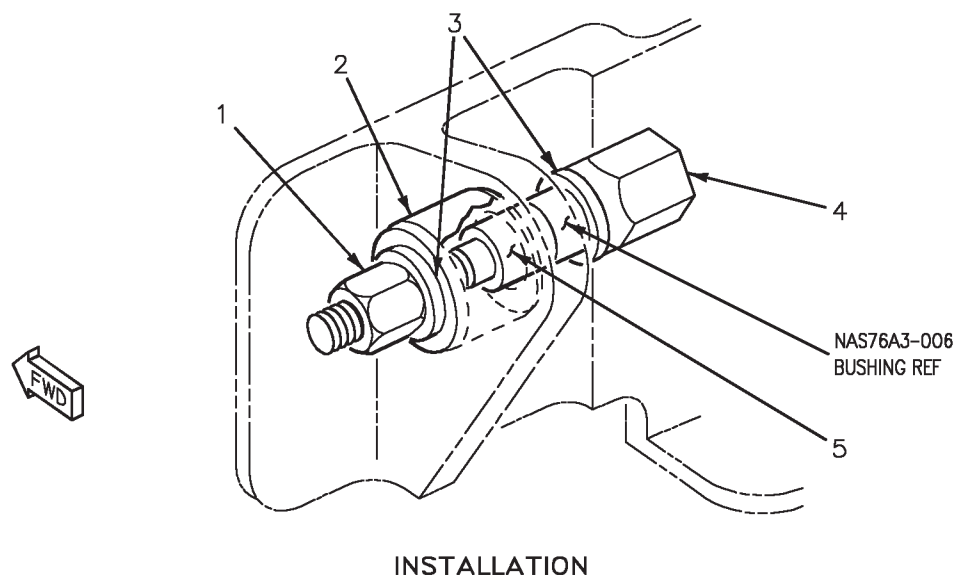
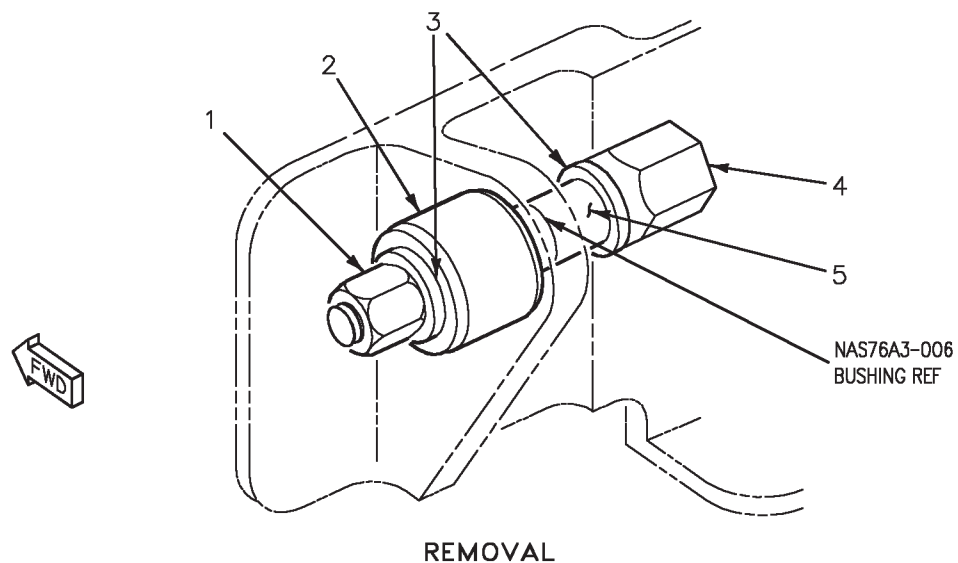
M CONT.

INDEX NO.	PART NUMBER	NOMENCLATURE	USE
1	74D111355-2115	BOLT	REM
2	74D111355-2017	WASHER	REM/INST
3	74D111355-2081	HOUSING	REM
4	74D111355-2079	GUIDE	REM/INST
5	AN960-716	WASHER	REM/INST
6	74D111355-2131	NUT	REM/INST
7	74D111355-2125	BOLT	REM/INST
8	74D111355-2085	GUIDE	REM
9	74D111355-2077	HOUSING	INST
10	74D111355-2027	BOLT	REM/INST
11	AN960-816	WASHER	REM/INST
12	74D111355-2029	NUT	REM/INST
13	74D111355-2083	GUIDE	REM/INST
14	74D111355-2049	HOUSING	INST
15	74D111355-2057	WASHER	INST

LEGEND			
1.	REMOVAL AND INSTALLATION OF 74A150739-2003,-2004, AND -2005 BUSHINGS ON 74A150821; STEPS 1,2, AND 6.		
2.	REMOVAL AND INSTALLATION OF ST4M139C13-60 BUSHING ON 74A150821; STEPS 3,4, AND 5.		

18AC-SRM-20-(205-21)21-CATI

Figure 4. Bushing Removal, Installation, and Reaming (Sheet 21)



N

INDEX NO.	PART NUMBER	NOMENCLATURE	USE
1	74D111355-2113	NUT	REM/INST
2	74D111355-2107	HOUSING	REM/INST
3	AN960-10	WASHER	REM/INST
4	74D111355-2109	BOLT	REM/INST
5	74D111355-2111	SLEEVE	REM/INST
<p style="text-align: center;">LEGEND</p> <p>1. REMOVAL AND INSTALLATION OF NAS76A3-006 BUSHING ON 74A150811, 74A150853, 74A150828, 74A150829, 74A150831, AND 74A150833 LUG.</p>			

18AC-SRM-20-(205-22)21-CATI

Figure 4. Bushing Removal, Installation, and Reaming (Sheet 22)

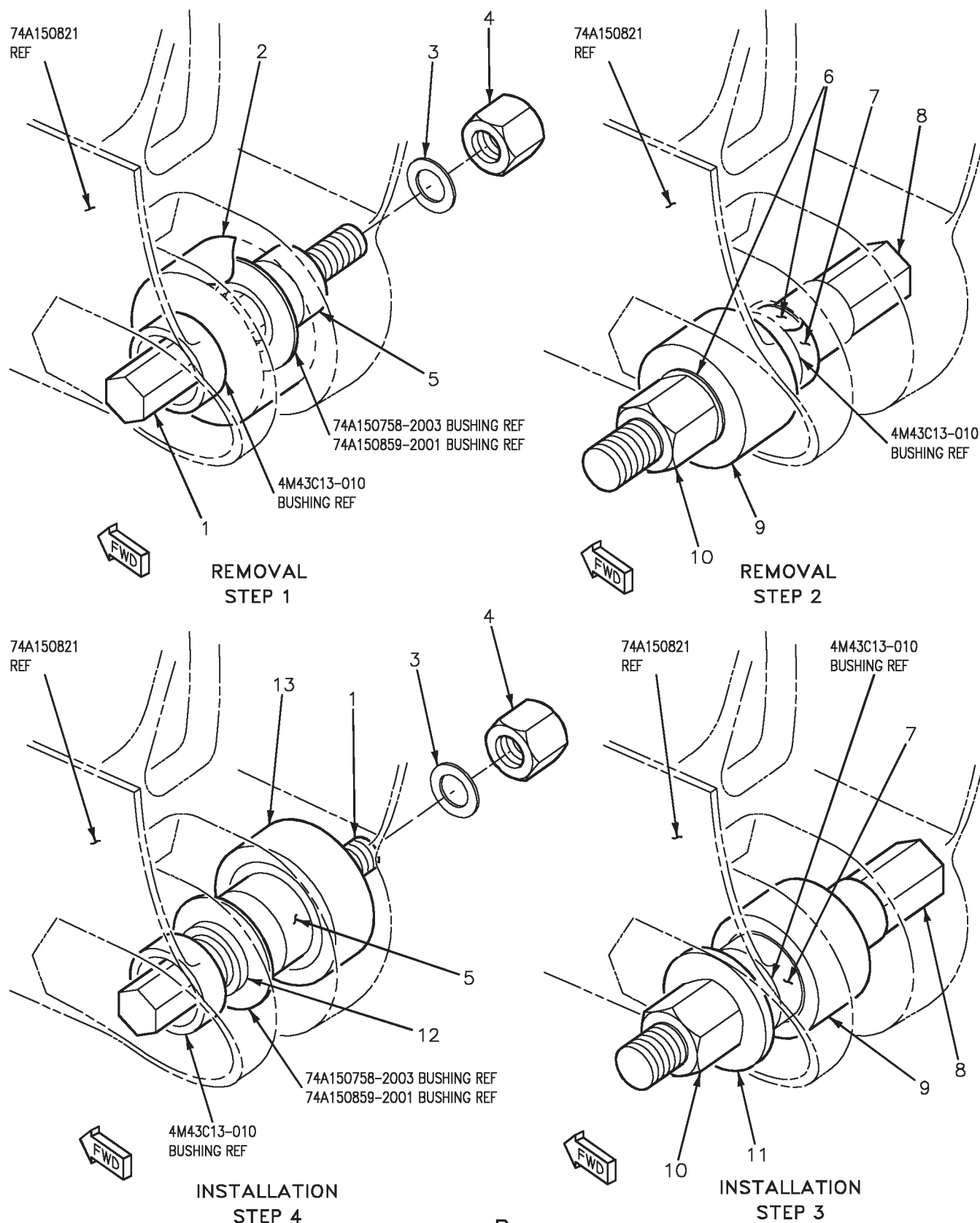
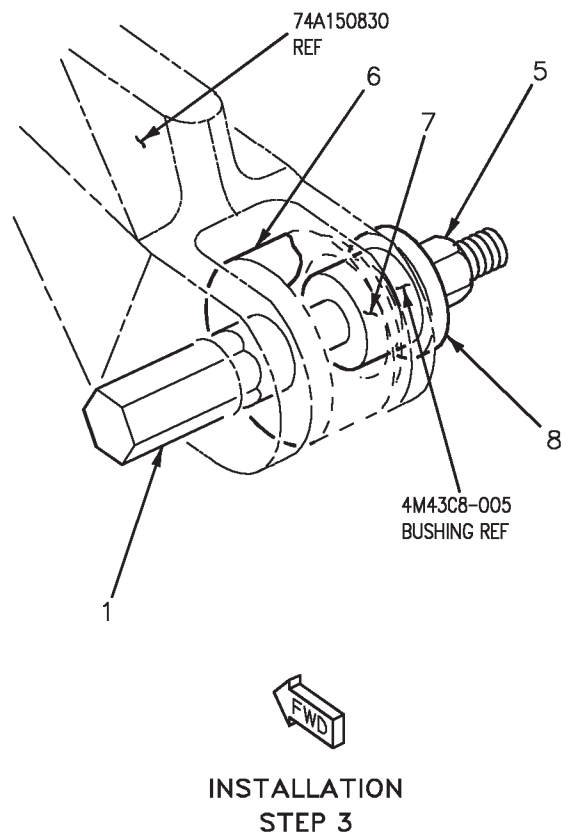
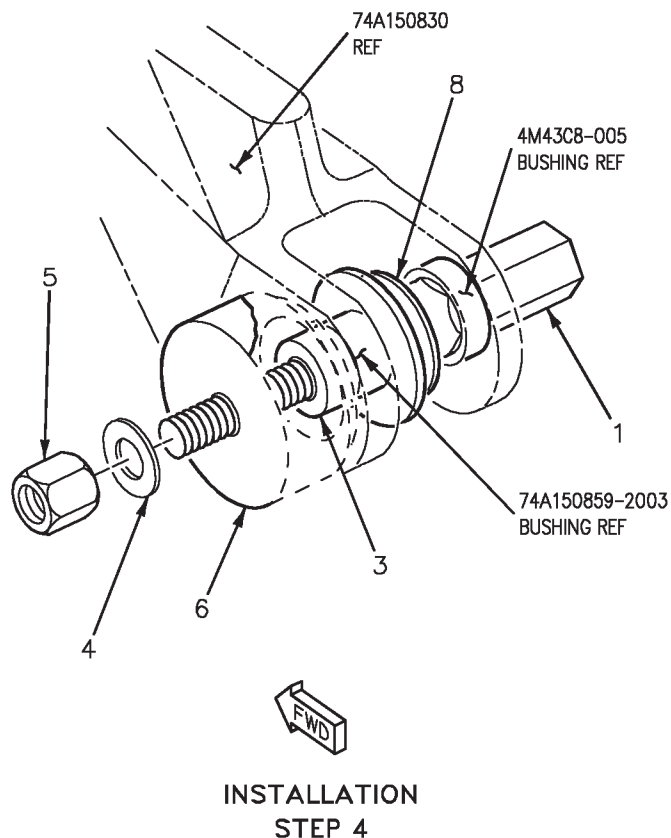
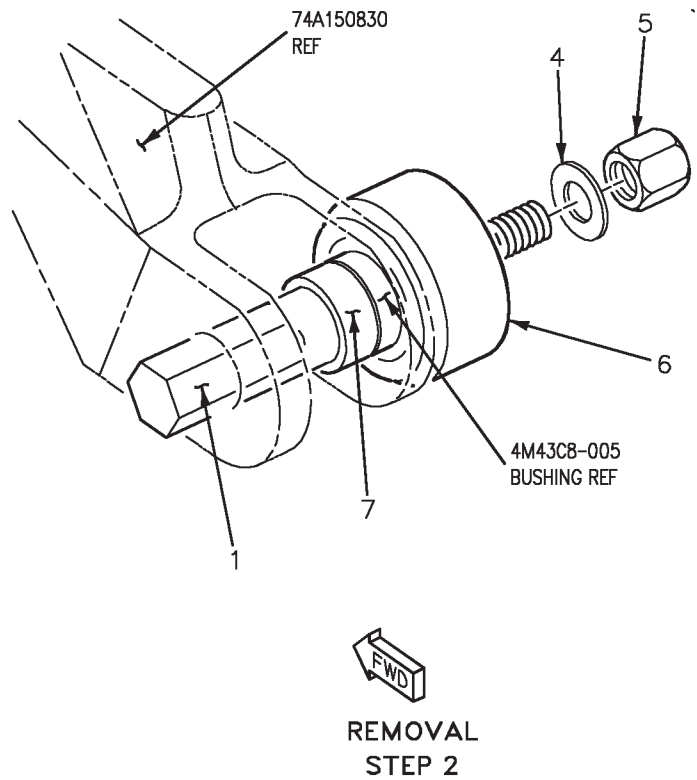
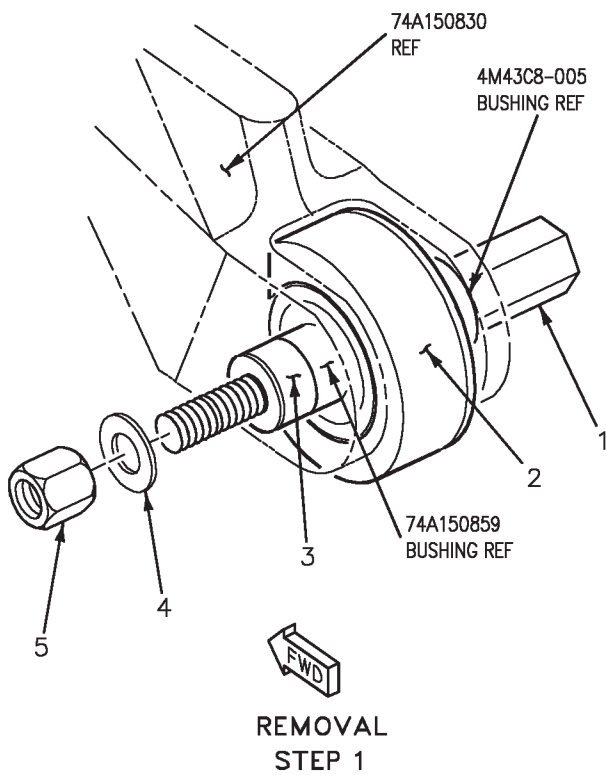


Figure 4. Bushing Removal, Installation, and Reaming (Sheet 23)

P CONT.

INDEX NO.	PART NUMBER	NOMENCLATURE	USE
1.	74D111355-2015	BOLT	REM/INST
2.	74D111355-2087	HOUSING	REM
3.	AN960-616	WASHER	REM/INST
4.	74D111355-2061	NUT	REM/INST
5.	74D111355-2089	GUIDE	REM/INST
6.	AN960-816	WASHER	REM
7.	74D111355-2095	GUIDE	REM/INST
8.	74D111355-2027	BOLT	REM/INST
9.	74D111355-2049	HOUSING	REM/INST
10.	74D111355-2029	NUT	REM/INST
11.	74D111355-2057	WASHER	INST
12.	74D111355-2093	WASHER	INST
13.	74D111355-2011	HOUSING	INST
<p style="text-align: center;">LEGEND</p> <p>1. REMOVAL AND INSTALLATION OF 74A150758-2003 AND 74A150859-2001 BUSHINGS ON 74A150821.</p> <p>2. REMOVAL AND INSTALLATION OF 4M43C13-010 BUSHING ON 74A150821 CLEVIS.</p>			

Figure 4. Bushing Removal, Installation, and Reaming (Sheet 24)



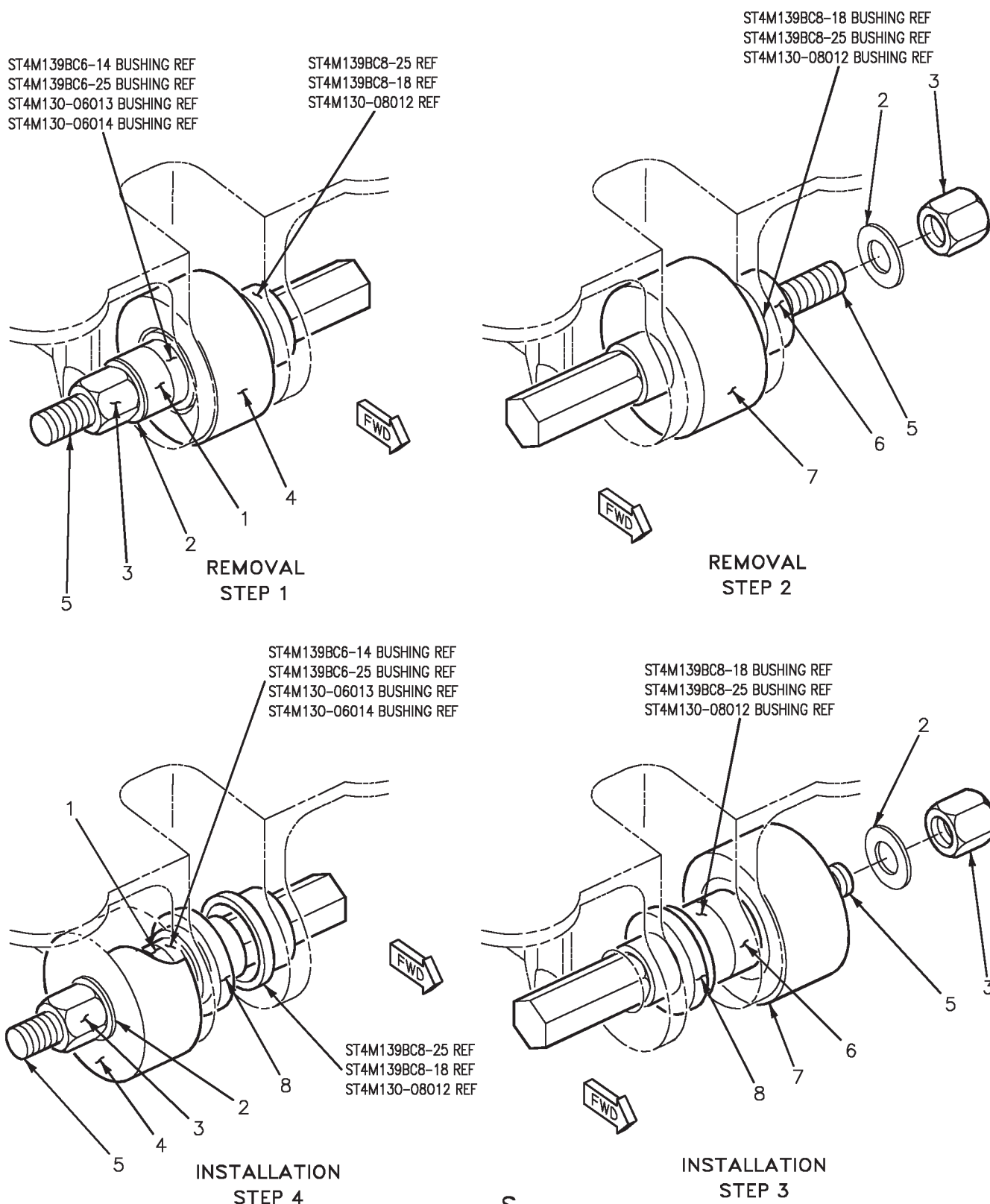
R

Figure 4. Bushing Removal, Installation, and Reaming (Sheet 25)

R CONT.

INDEX NO.	PART NUMBER	NOMENCLATURE	USE
1	74D111355-2055	BOLT	REM/INST
2	74D111355-2053	HOUSING	REM
3	74D111355-2051	GUIDE	REM/INST
4	AN960-416	WASHER	REM/INST
5	74D111355-2007A	NUT	REM/INST
6	74D111355-2075	HOUSING	REM/INST
7	74D111355-2097	GUIDE	REM/INST
8	74D111355-2073	WASHER	INST
LEGEND			
1. REMOVAL AND INSTALLATION OF 74A150859-2003 AND 4M43C8-005 BUSHINGS ON 74A150830 CLEVIS.			

Figure 4. Bushing Removal, Installation, and Reaming (Sheet 26)



S CONT.

INDEX NO.	PART NUMBER	DESCRIPTION	MATERIAL
1	74D111355-2069	GUIDE	REM/INST
2	AN960-416	WASHER	REM/INST
3	74D111355-2007A	NUT	REM/INST
4	74D111355-2067	HOUSING	REM/INST
5	74D111355-2055	BOLT	REM/INST
6	74D111355-2071	GUIDE	REM/INST
7	74D111355-2075	HOUSING	REM/INST
8	74D111355-2073	WASHER	INST
LEGEND			
1. REMOVAL AND INSTALLATION OF ST4M130-06013, ST4M139BC6-14, AND ST4M139BC8-18 BUSHINGS ON 74A150678 CLEVIS.			
2. TYPICAL FOR REMOVAL AND INSTALLATION OF ST4M130-06014, ST4M139BC6-25, ST4M139BC8-25, AND ST4M130-08012 BUSHINGS ON 74A150679 CLEVIS.			

Figure 4. Bushing Removal, Installation, and Reaming (Sheet 28)

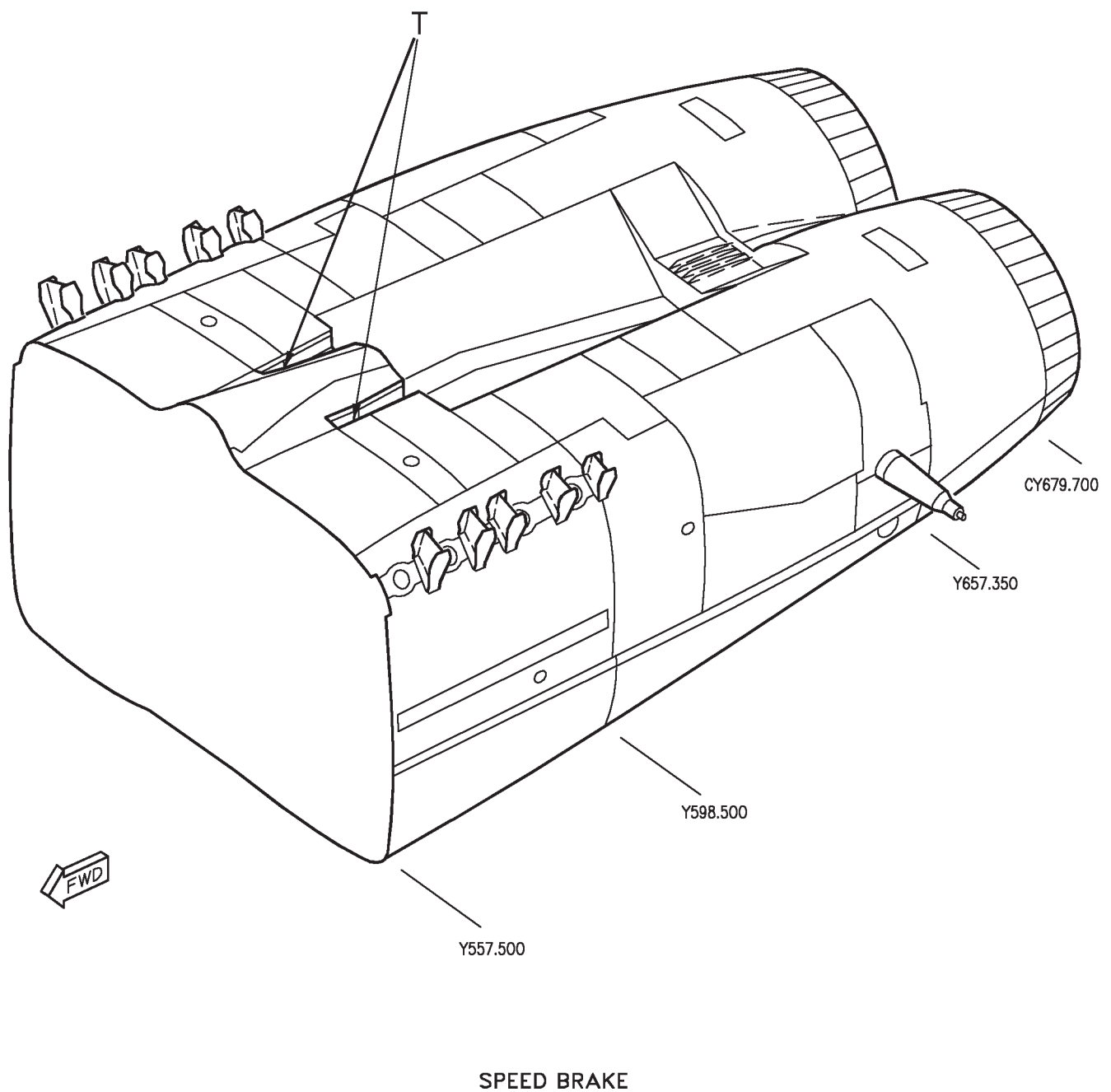


Figure 4. Bushing Removal, Installation, and Reaming (Sheet 29)

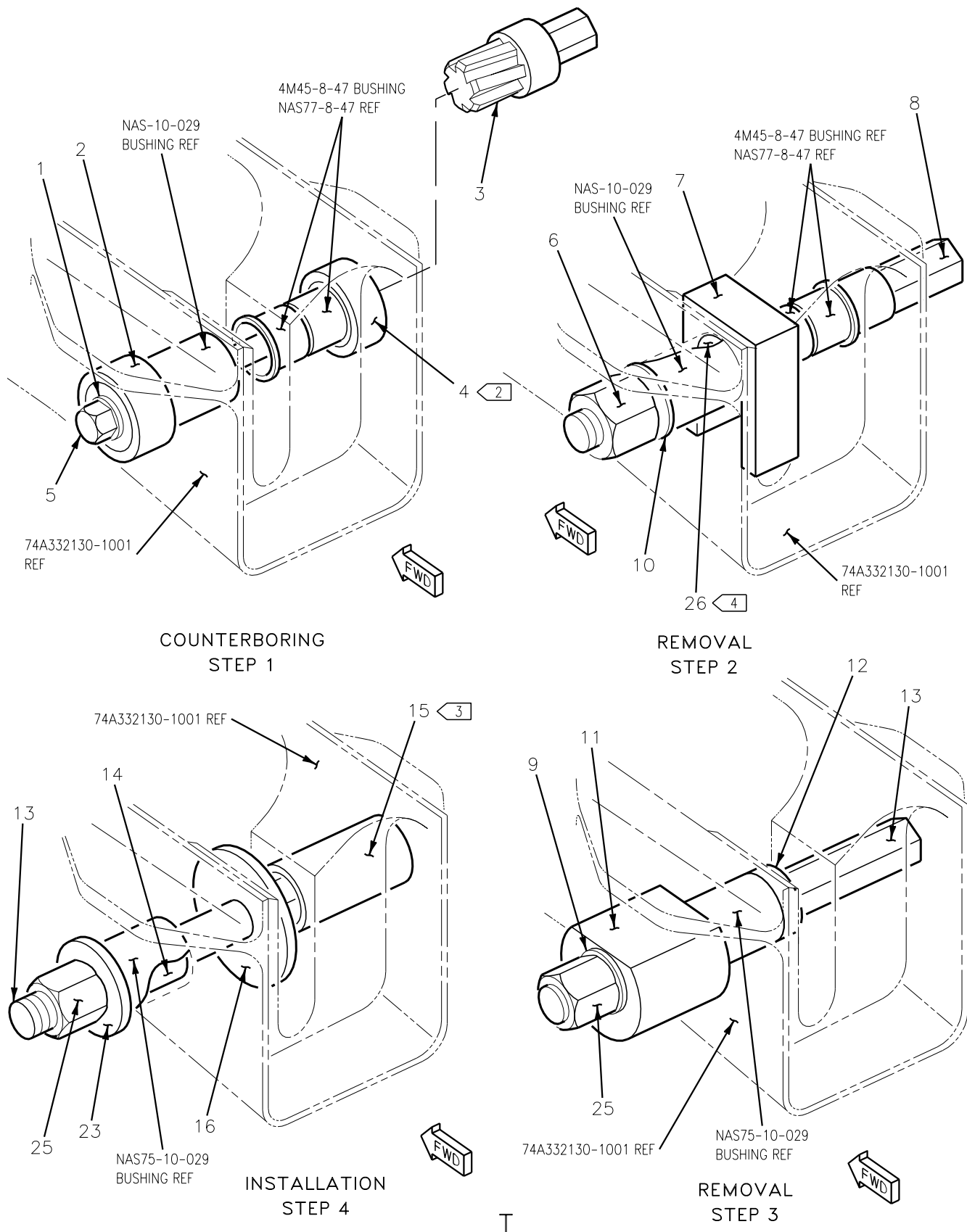
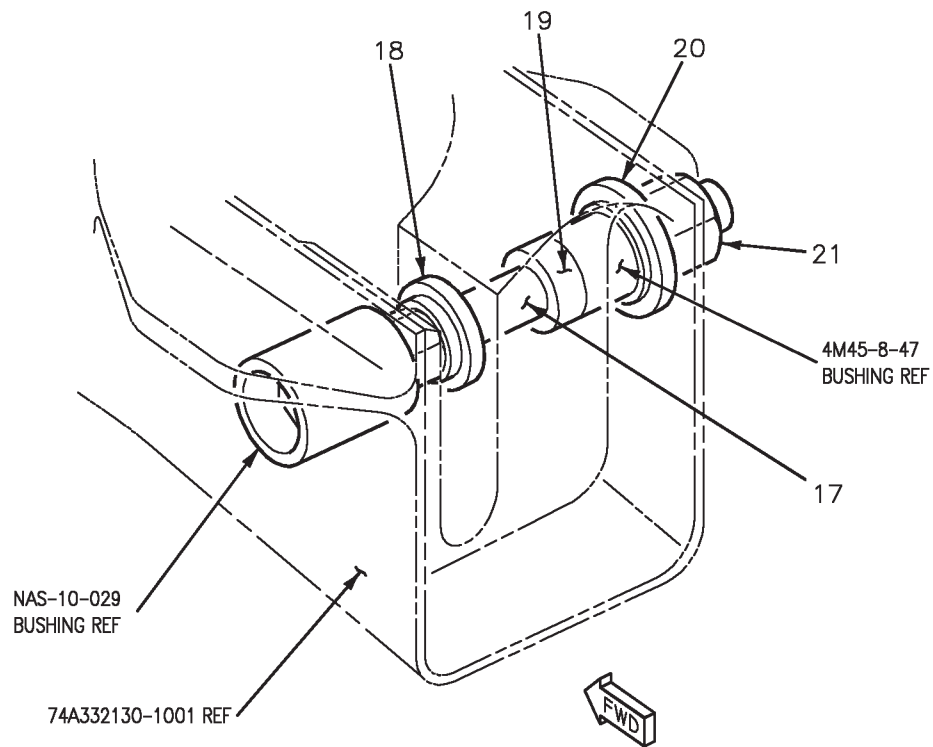
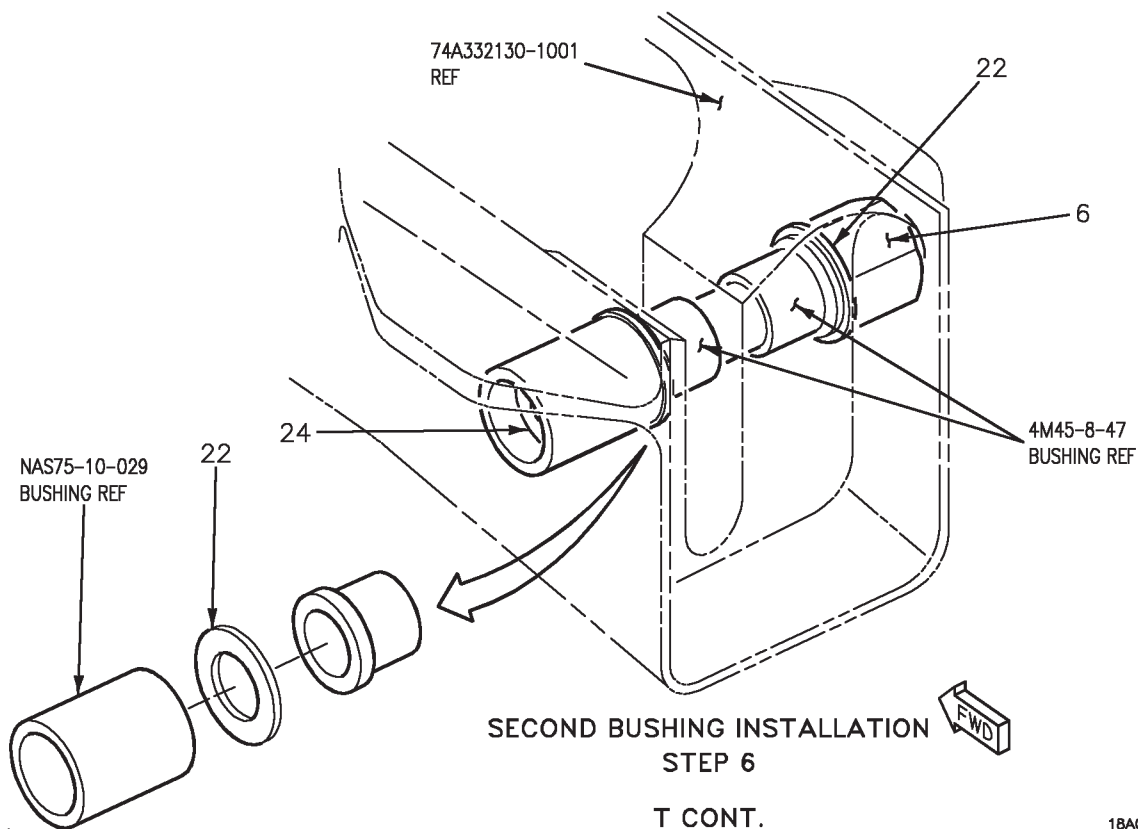


Figure 4. Bushing Removal, Installation, and Reaming (Sheet 30)



FIRST BUSHING INSTALLATION
STEP 5







SECOND BUSHING INSTALLATION
STEP 6

T CONT.


Figure 4. Bushing Removal, Installation, and Reaming (Sheet 31)


T CONT.

INDEX NO.	PART NUMBER	NOMENCLATURE	USE
1	AN960-416	WASHER	COUNTERBORING
2	74D111355-1001	BEARING	COUNTERBORING
3	SPT21-74D110174-5001TD	CUTTER	COUNTERBORING
4	74D111355-2135 	SLEEVE	COUNTERBORING
5	NAS1351-4-44P	BOLT	COUNTERBORING
6	74D111355-2029	NUT	REM/INST
7	74D111355-2145	SPACER	REM
8	74D111355-2147A	BOLT	REM
9	AN960-716	WASHER	REM
10	74D111355-2057	WASHER	REM
11	74D111355-2139	HOUSING	REM
12	74D111355-2037	GUIDE	REM
13	74D111355-2039A	BOLT	REM/INST
14	74D111355-2129	SLEEVE	INST
15	74D111355-2127 	SLEEVE	INST
16	74D111355-2063	WASHER	INST
17	74D111355-2015	BOLT	INST
18	74D111355-2093	WASHER	INST
19	74D111355-2133	GUIDE	INST
20	74D111355-2143	WASHER	INST
21	74D111355-2061	NUT	INST
22	AN960-816	WASHER	INST/REM
23	74D111355-2031 	WASHER	INST
24	74D111355-2091	BOLT	INST
25	74D111355-2131	NUT	REM/INST
26	74D111355-2123 	PLATE	REM

LEGEND

1. REMOVAL AND INSTALLATION OF 4M45-8-47, NAS77-8-47, AND NAS75-10-029 BUSHINGS ON 74A332130.

 USED TO CENTER CUTTER IN WORN BUSHING.

 USED ONLY ON REPAIR OF 74A332130-1002 FITTING.


 TO PREVENT ENTRAPMENT OF BUSHINGS, USE THIS PLATE AS A FEELER GAUGE TO MONITOR BUSHING TRAVEL. TANDEM BUSHINGS MUST BE REMOVED AS SEPARATE PIECES.

Figure 4. Bushing Removal, Installation, and Reaming (Sheet 32)

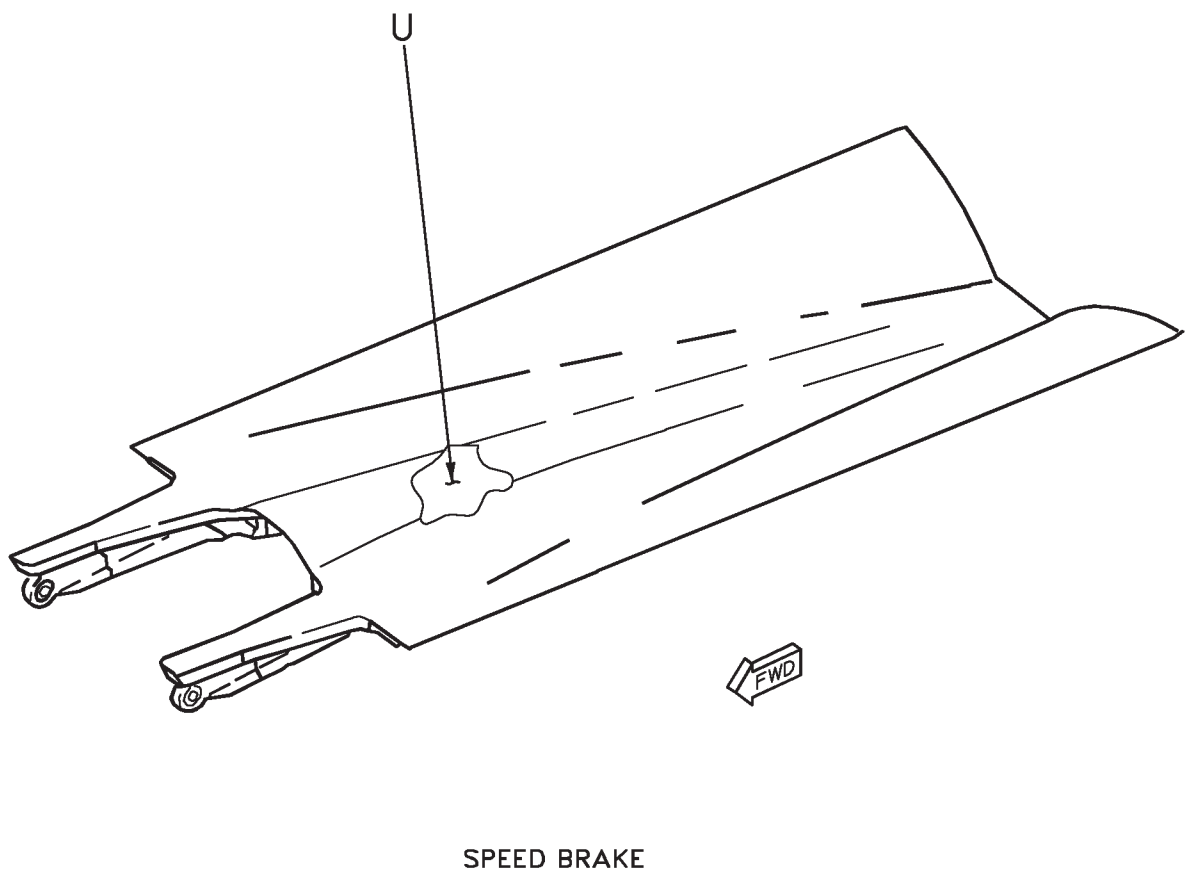
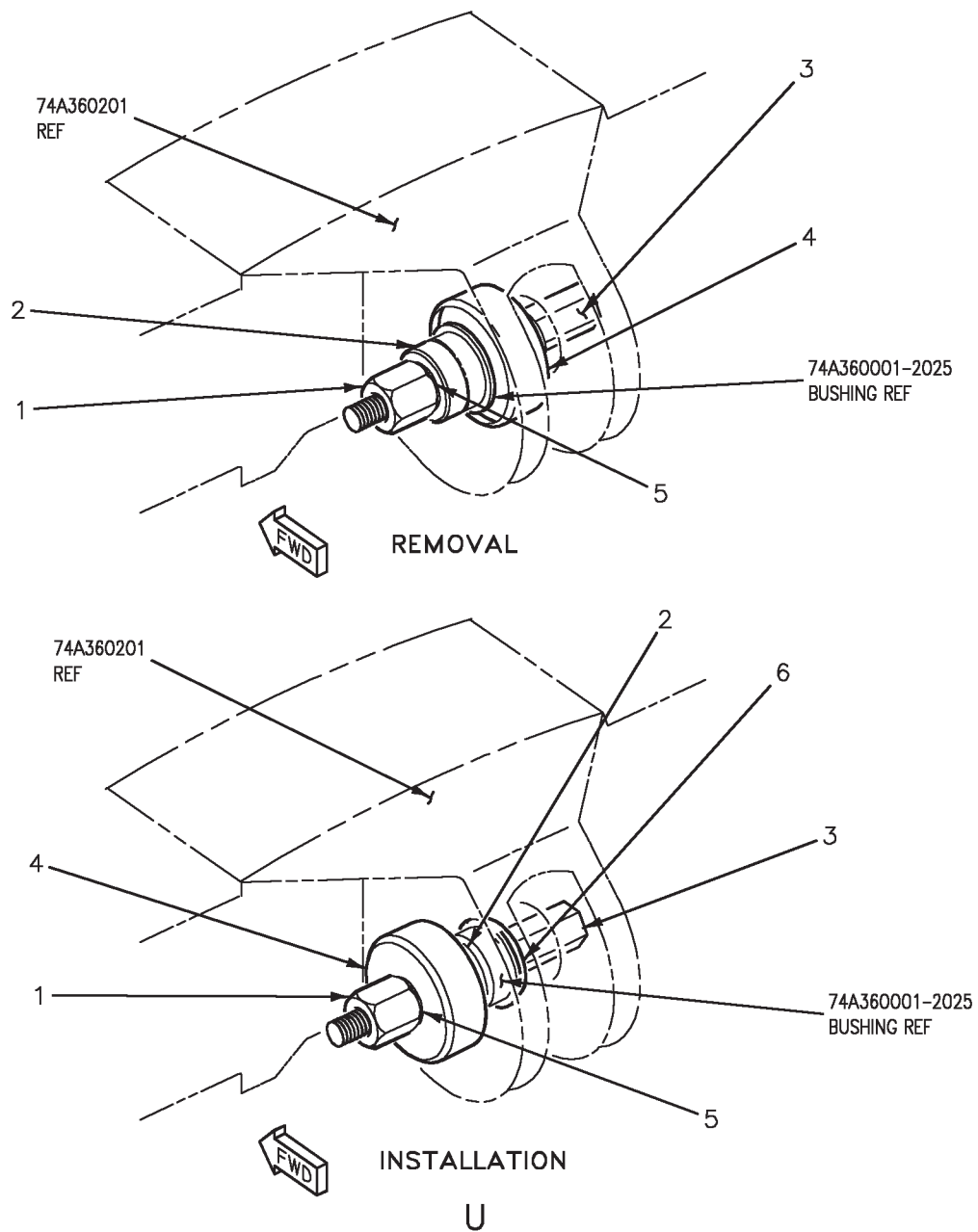


Figure 4. Bushing Removal, Installation, and Reaming (Sheet 33)



INDEX NO.	PART NUMBER	NOMENCLATURE	USE
1	74D111355-2061	NUT	REM/INST
2	74D111355-2003	GUIDE	REM/INST
3	74D111355-2015	BOLT	REM/INST
4	74D111355-2011	HOUSING	REM/INST
5	AN960-616	WASHER	REM/INST
6	74D111355-2143	WASHER	INST

LEGEND

1. REMOVAL AND INSTALLATION OF 74A360001-2025 BUSHING ON 74A360201 CLEVIS.

Figure 4. Bushing Removal, Installation, and Reaming (Sheet 34)

INTERMEDIATE MAINTENANCE

STRUCTURE REPAIR

BEARING REMOVAL AND INSTALLATION TOOL SET

PART NO. 74D110166-1001

Reference Material

Structure Repair, General Information	A1-F18AC-SRM-200
Adhesive, Cement and Sealant; Preparation and Application.....	WP011 00
Aircraft Corrosion Control.....	A1-F18AC-SRM-500
Finish System	WP012 00

Alphabetical Index

Subject	Page No.
Bearing Removal and Installation Tool Set.....	1
Bearing Installation	2
Bearing Removal	1
Trailing Edge Flap.....	4

Record of Applicable Technical Directives

None

1. **BEARING REMOVAL AND INSTALLATION TOOL SET.** See figures 1 through 9.

2. Bearing removal and installation tool set is used on many linear actuating mechanisms and linkages. These mechanisms use low friction, monoball, roller bearings in aluminum housings at hinge and support points. Bearings are held in position by staking part of grooved outer race into chamfer or beveled area on either side of housing bore. When tolerances are exceeded due to wear or other unsatisfactory conditions, these bearings must be replaced.

3. **BEARING REMOVAL.**

Support Equipment Required

Part Number or Type Designation	Nomenclature
—	Micrometer

Materials Required**NOTE**

Alternate item part numbers are shown indented.

**Specification
or Part Number****Nomenclature**

DS-108F	Solvent, Wipe
30401720	Cleaning Compound
CCC-C-46, TYPE 1, CLASS 4	Cleaning Cloth
MIL-L-7808	Lubricating Oil
ISOPAR M	Cutting Fluid, Liquid Coolant
MIL-S-81733	Sealing Compound, Sealing and Coating Compound

a. Cutting damaged bearing flange:

- (1) Select correct cutting tools.

WARNING

Solvent should be used with care. Gloves must be worn to prevent injury.

Cleaning compound may cause eye and skin irritation. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

- (2) Clean cutting tools with cleaning cloth moistened with solvent or cleaning compound. Make sure tools are clean and free of foreign material.

WARNING

Lubricating oil contains materials hazardous to health and produces paralysis if swallowed. Prolonged contact may irritate skin. Wash hands thoroughly after handling. Use in a well ventilated area. Lubricating oil may burn if exposed to heat or flame.

- (3) Lubricate cutting tools.
- (4) Assemble cutting tools.

WARNING

Cutting fluid is flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

- (5) Use cutting fluid on cutter edges during cutting procedure.

CAUTION

Cut bearing flange to minimum thickness or damage to housing may result.

NOTE

Use cutting tools in one direction only.

- (6) Cut flange from one side of bearing by turning bolt with wrench.

- (7) Remove cutting tools.

- (8) Clean cutting tools with lubricating oil moistened cloth and store.

b. Removing damaged bearing:

- (1) Select correct removal tools.

- (2) Clean removal tools with cleaning cloth moistened with solvent or cleaning compound. Make sure tools are clean and free of foreign material.

- (3) Lubricate removal tools.

- (4) Assemble removal tools.

- (5) To remove bearing apply pressure on cut side by turning nut with wrench.

- (6) Remove removal tools.

- (7) Clean removal tools with lubricating oil moistened cloth and store.

4. BEARING INSTALLATION.

- a. Install new bearing. Following assembly bearings are wet installed with sealing compound;

- L/R Trailing edge flap inboard hinge assembly, 74A180684
- L/R Trailing edge flap outboard hinge assembly, 74A180691
- L/R Aileron drive hinge assembly, 74A170604
- L/R Aileron outboard hinge assembly, 74A170762

- (1) Select correct installation tools.

WARNING

Solvent should be used with care. Gloves must be worn to prevent injury.

Cleaning compound may cause eye and skin irritation. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

- (2) Clean installation tools with cleaning cloth moistened with solvent or cleaning compound. Make sure tools are clean and free of foreign material.

WARNING

Lubricating oil contains materials hazardous to health and produces paralysis if swallowed. Prolonged contact may irritate skin. Wash hands thoroughly after handling. Use in a well ventilated area. Lubricating oil may burn if exposed to heat or flame.

- (3) Lubricate installation tools.

- (4) Assemble installation tools.

- (5) Install bearing by turning nut with wrench. Installation tool centers, aligns, and installs bearing.

- (6) Remove bearing installation tools.

- (7) Clean installation tools with lubricating oil moistened cloth and store.

- b. Stake new bearings in housing:

- (1) Select correct staking tools.

- (2) Clean staking tools with cleaning cloth moistened with solvent or cleaning compound. Make sure tools are clean and free of foreign material.

- (3) Lubricate staking tools.

- (4) Assemble staking tools.

NOTE

Measurement before tightening nut may not be zero.

- (5) Stake first side of bearing by turning nut with wrench. As nut is tightened, measure from surface of bolt head to end of pin in center of bolt using micrometer. When bolt stretch due to tightening nut is 0.0067 ± 0.0005 as indicated by differential movement between bolt head surface and end of pin, bearing is correctly staked. See figures 2, 3, 5, 6, 7, 8, and 9 for location of micrometer measurement.

NOTE

Measurement before tightening nut may not be zero.

- (6) Stake second side of bearing by turning nut with wrench. As nut is tightened, measure from surface of bolt head to end of pin in center of bolt using micrometer. When bolt stretch due to tightening nut is 0.0067 ± 0.0005 as indicated by differential movement between bolt head surface and end of pin, bearing is correctly staked. See figures 2, 3, 5, 6, 7, 8, and 9 for location of micrometer measurement.

- (7) Remove staking tools.

- (8) Clean staking tools with lubricating oil moistened cloth and store.

5. Edge Sealing. Inboard and outboard trailing edge flap hinge lug assemblies and aileron drive and outboard hinge lug assemblies shall have sealing compound applied around bearing/lug interface.

WARNING

Solvent should be used with care. Gloves must be worn to prevent injury.

a. Clean interface area with solvent moistened cloth to make sure interface area is free of contamination or foreign material.

b. Wipe solvent from around interface area with clean dry cloth.

c. Repeat steps a and b until no residue is visible on clean dry cloth.

d. Allow to air dry 15 minutes before application of sealing compound.

NOTE

Sealing compound shall not contact bearing inner ring.

e. Apply light coat of sealing compound to edges of bearing outer ring and surrounding housing area. Sealing compound shall cover exterior edge of bearing outer ring and should cover approximately 0.125 to 0.250 of surrounding housing area. For sealant preparation and application (WP011 00).

f. After sealing compound cures, touchup area with primer/paint (A1-F18AC-SRM-500, WP012 00).

6. **TRAILING EDGE FLAP.** See figure 5.

a. Cutting. See figure 5, step 1.

- (1) Select correct cutting tools:
 - 74D111290-1021 cutter assembly
 - 74D111290-2069 anvil
 - 74D111290-2055 bolt

WARNING

Solvent should be used with care. Gloves must be worn to prevent injury.

Cleaning compound may cause eye and skin irritation. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

(2) Clean cutting tools with cleaning cloth moistened with solvent or cleaning compound. Make sure tools are clean and free of foreign material

WARNING

Lubricating oil contains materials hazardous to health and produces paralysis if swallowed. Prolonged contact may irritate skin. Wash hands thoroughly after handling. Use in a well ventilated area. Lubricating oil may burn if exposed to heat or flame.

(3) Lubricate cutting tools.

(4) Assemble cutting tools:

(a) Install 74D111290-2055 bolt through 74D111290-2069 anvil and MS14101-14 bearing.

(b) Thread 74D111290-1021 cutter assembly onto 74D111290-2055 bolt.

WARNING

Cutting fluid is flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

CAUTION

Cut bearing flange to minimum thickness or damage to housing may result.

NOTE

Use cutting fluid on cutter assembly edges during cutting procedure. Turn cutter assembly in one direction only.

(5) Cut flange from one side of bearing by turning 74D111290-1021 cutter assembly with wrench.

(6) Remove cutting tools.

NOTE

Do not back out 74D111290-1021 cutter assembly.

(a) Back out 74D111290-2055 bolt

(b) Clean cutting tools with lubricating oil moistened cloth and store.

b. Removing. See figure 5, step 2.

(1) Select correct removal tools:

74D111291-2049	bolt
74D111291-2045	guide
74D111291-2043	housing
AN960C1416	washer (2 required)
AN315-14R	nut

(2) Clean removal tools with cleaning cloth moistened with solvent or cleaning compound. Make sure tools are clean and free of foreign material.

(3) Lubricate removal tools.

(4) Assemble removal tools:

(a) Install 74D111291-2049 bolt through AN960C1416 washer, 74D111291-2045 guide, MS14101-14 bearing, 74D111291-2043 housing, and AN960C1416 washer.

(b) Thread AN315-14R nut onto 74D111291-2049 bolt.

(c) Assemble removal tools so 74D111291-2045 guide rests flat against cut side of bearing.

(5) To remove bearing, apply pressure on cut side by turning nut with wrench until bearing rests in housing.

(a) Thread nut off bolt.

(b) Remove removal tools.

(c) Clean removal tools with lubricating oil moistened cloth and store.

c. Installing. See figure 5, step 3.

(1) Select correct installation tools:

74D111291-2049	bolt
74D111291-2047	pusher
74D111291-2045	guide
74D111291-2043	housing
AN315-14R	nut
AN960C1416	washer (2 required)

(2) Clean installation tools with cleaning cloth moistened with solvent or cleaning compound. Make sure tools are clean and free of foreign material.

(3) Lubricate installation tools.

(4) Assemble installation tools:

(a) Install 74D111291-2049 bolt through AN960C1416 washer, 74D111291-2047 pusher, MS14101-14 bearing, 74D111291-2045 guide, 74D111291-2043 housing, and AN960C1416 washer.

(b) Thread AN315-14R nut onto 74D111291-2049 bolt.

WARNING

Sealant materials are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

(5) Install bearing wet with sealing compound by turning nut with wrench until 74D111291-2047 pusher rests flat against bearing housing. For sealant preparation and application (WP011 00).

(6) Thread nut off bolt.

(7) Remove installation tools.

(8) Clean installation tools with lubricating oil moistened cloth and store.

d. Staking first side. See figure 5, step 4.

(1) Select correct staking tools:

74D111292-2053	nut
74D111291-2047	pusher
74D111292-2037	anvil
74D111292-1011	bolt assembly
AN960C1416	washer (2 required)

(2) Clean staking tools with cleaning cloth moistened with solvent or cleaning compound. Make sure tools are clean and free of foreign material.

(3) Lubricate staking tools.

(4) Assemble staking tools:

(a) Install 74D111292-1011 bolt assembly through AN960C1416 washer, 74D111292-2037 anvil, MS14101-14 bearing, 74D111291-2047 pusher, and AN960C1416 washer.

(b) Thread 74D111292-2053 nut onto bolt assembly.

NOTE

Initial measurement before tightening nut may not be zero.

(5) Take initial measurement from surface of bolt head to end of pin in center of bolt assembly with depth micrometer before tightening nut.

(6) Stake first side of bearing by turning nut with wrench. When bolt stretch due to tightening nut is 0.0067 ± 0.0005 inch as indicated by differential movement from initial measurement of pin, bearing is correctly staked.

(7) Thread 74D111292-2053 nut off 74D111292-1011 bolt assembly.

(8) Remove staking tools.

(9) Inspect for satisfactory staking on first side of bearing.

(10) Clean staking tools with lubricating oil moistened cloth.

e. Staking second side. See figure 5, step 5.

(1) Select correct staking tools:

74D111292-2053	nut
AN960C1416	washer (2 required)
74D111292-2037	anvil (2 required)
74D111292-1011	bolt assembly

(2) Clean staking tools with cleaning cloth moistened with solvent or cleaning compound. Make sure tools are clean and free of foreign material.

(3) Assemble staking tools:

(a) Slide 74D111292-2037 anvil and AN960C1416 washer onto 74D111292-1011 bolt assembly.

(b) Install 74D111292-1011 bolt assembly through MS14101-14 bearing.

(c) Slide 74D111292-2037 anvil and AN960C1416 washer onto 74D111292-1011 bolt assembly.

(d) Thread 74D111292-2053 nut onto bolt assembly.

NOTE

Initial measurement before tightening nut may not be zero.

(4) Take initial measurement from surface of bolt assembly head to end of pin in center of bolt with depth micrometer before tightening nut.

(5) Stake second side of bearing by turning nut with wrench. When bolt stretch, due to tightening nut, is 0.0067 ± 0.0005 inch as indicated by differential movement of pin, bearing is correctly staked.

(6) Thread nut off bolt.

(7) Remove staking tools.

(8) Clean staking tools with lubricating oil moistened cloth and store.

(9) Inspect second side staking to make sure of satisfactory staking and free rotation of bearing.

WARNING

Solvent should be used with care. Gloves must be worn to prevent injury.

f. Clean interface area with solvent moistened cloth to make sure interface area is free of contamination or foreign material.

g. Wipe solvent from around interface area with clean dry cloth.

h. Repeat steps f and g until no residue is visible on clean dry cloth.

i. Allow to air dry 15 minutes before application of sealing compound.

WARNING

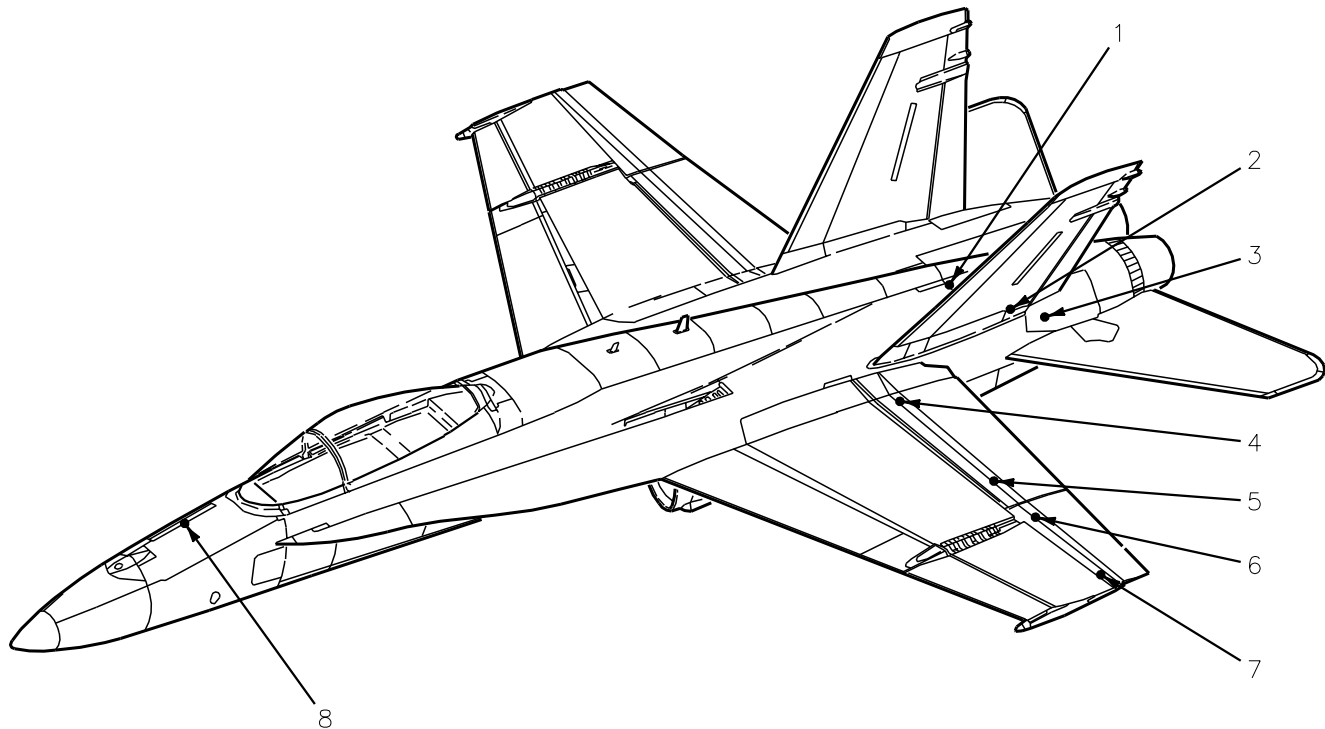
Sealant materials are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

NOTE

Sealing compound shall not contact bearing inner ring.

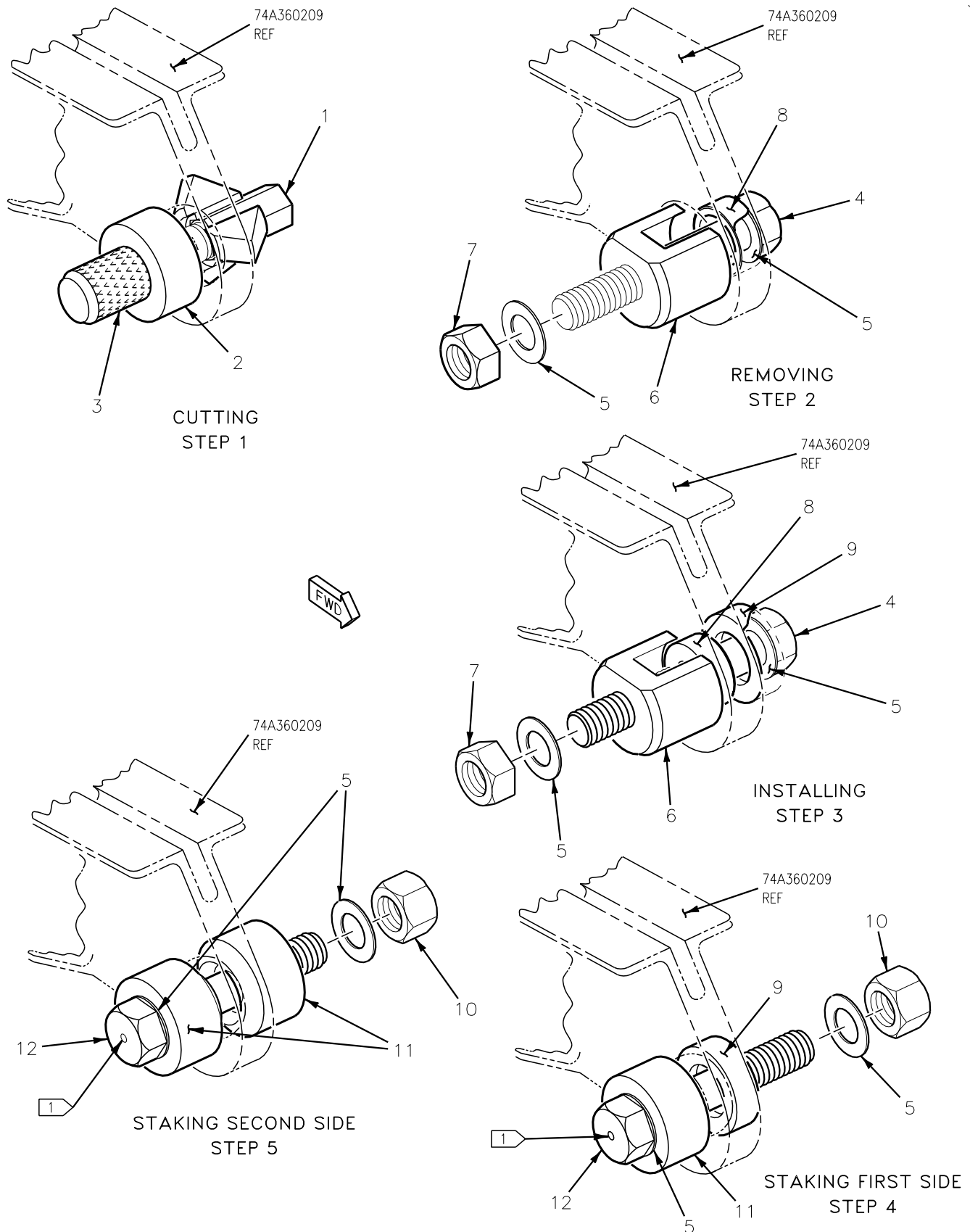
j. Apply light coat of sealing compound to edges of bearing outer ring and surrounding housing area. Sealing compound shall cover exterior edge of bearing outer ring and should cover approximately 0.125 to 0.250 of surrounding housing area. For sealant preparation and application (WP011 00).

k. After sealing compound cures, touchup area with primer/paint (A1-F18AC-SRM-500, WP012 00).



INDEX NO.	NOMENCLATURE	PART NUMBER	BEARING PART NUMBER
1	SPEED BRAKE HINGE HALF.	74A360209	MS14101-8
2	VERTICAL STABILIZER LOWER RIB 52.5%-62.5%.	74A230735	MS14101-12
3	HORIZONTAL STABILATOR STRUCTURAL COMPONENT SUPPORT.	74A331401	74B330064
4	TRAILING EDGE FLAP RIB ASSEMBLY DRIVE HINGE.	74A180684	MS14101-14
5	OUTBOARD HINGE TRAILING EDGE FLAP RIB.	74A180685	MS14103-8
6	AILERON HINGE INBOARD DRIVE ASSEMBLY RIB.	74A170604	MS14103-10
7	AILERON OUTBOARD HINGE ASSEMBLY.	74A170736	MS14103-6
		74A170762	MS14103-6
8	IFR PROBE ACTUATING CYLINDER SUPPORT ASSEMBLY.	74A313027	MS14101-6

Figure 1. Locations For Use of Bearing Removal and Installation Tool Set



18AC-SRM-20-(210-1)39-CAT1

Figure 2. Working MS14101-8 Bearing in 74A360209 Speed Brake Hinge Half (Sheet 1)

INDEX	NOMENCLATURE	PART NUMBER
1	CUTTER ASSEMBLY	74D111290-1005
2	ANVIL	74D111290-2061
3	BOLT	74D111290-2047
4	BOLT	74D111291-2015
5	WASHER	AN960C816
6	HOUSING	74D111291-2017
7	NUT	AN315-8R
8	GUIDE	74D111291-2019
9	PUSHER	74D111291-2021
10	NUT	74D111292-2047
11	ANVIL	74D111292-2015
12	BOLT ASSEMBLY	74D111292-1003

LEGEND

 USE MICROMETER HERE.

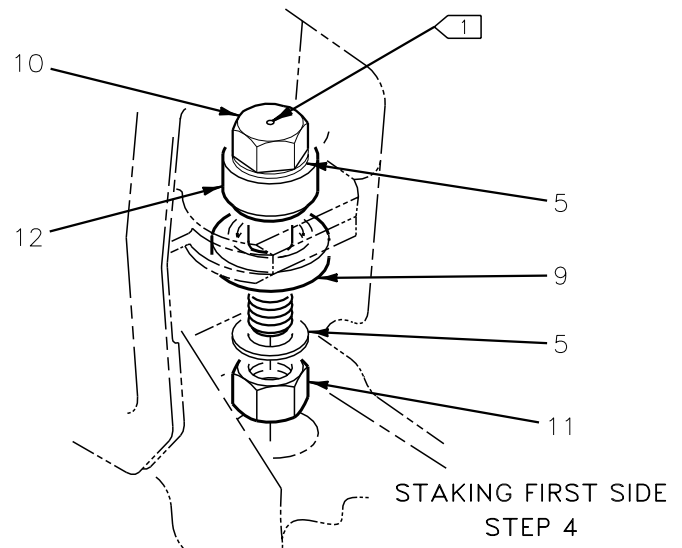
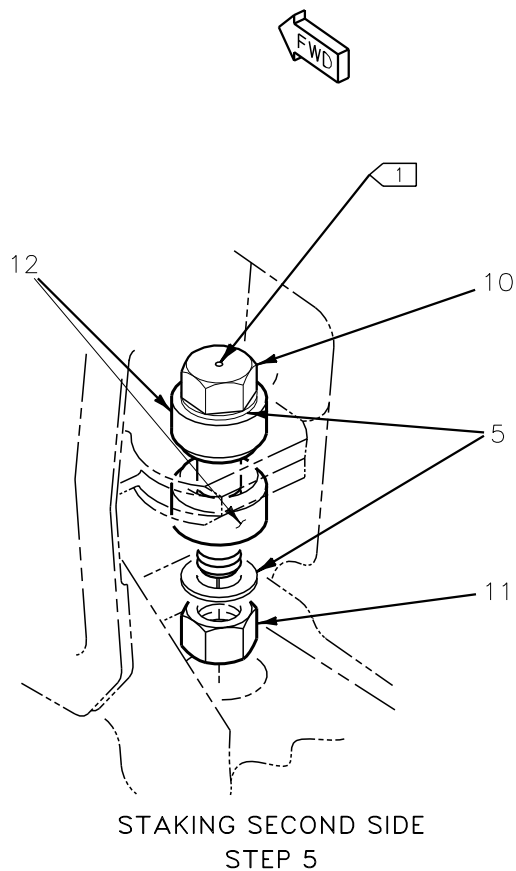
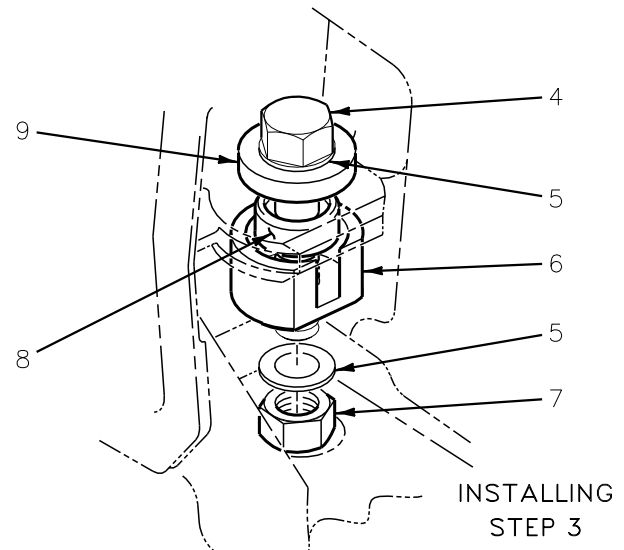
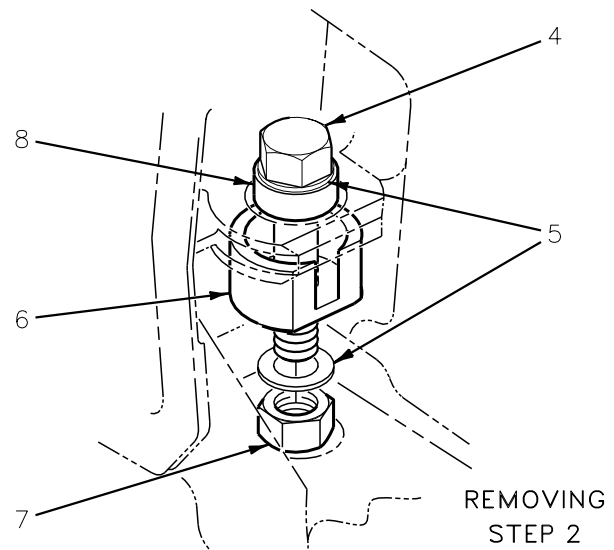
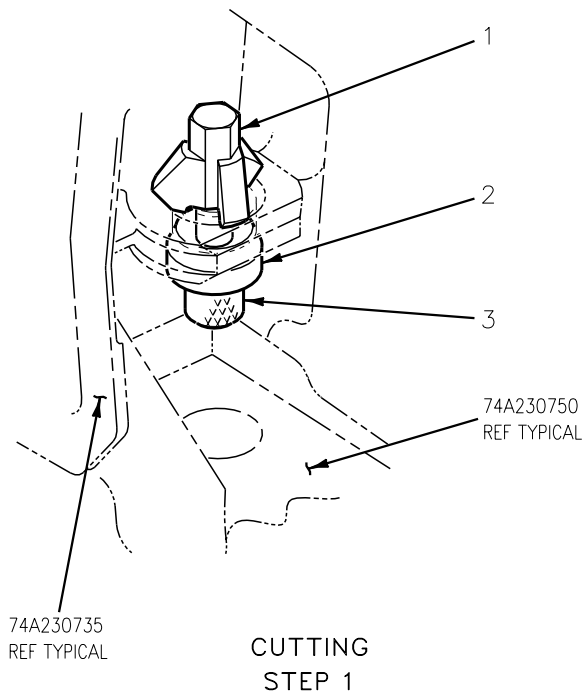


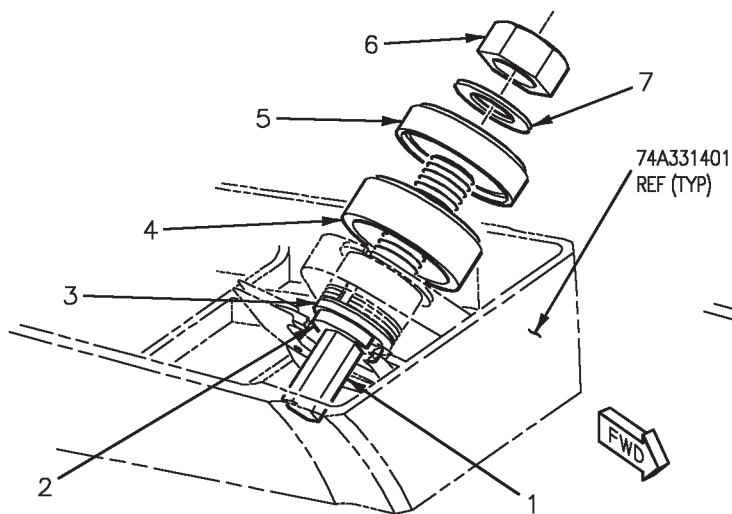
Figure 3. Working MS14101-12 Bearing in 74A230735 Vertical Stabilizer Lower Rib, 52.5% - 62.5% (Sheet 1)

INDEX	NOMENCLATURE	PART NUMBER
1	CUTTER ASSEMBLY	74D111290-1017
2	ANVIL	74D111290-2067
3	BOLT	74D111290-2053
4	BOLT	74D111291-2041
5	WASHER	AN960C1216
6	HOUSING	74D111291-2035
7	NUT	AN315-12R
8	GUIDE	74D111291-2037
9	PUSHER	74D111291-2039
10	BOLT ASSEMBLY	74D111292-1009
11	NUT	74D111292-2051
12	ANVIL	74D111292-2031

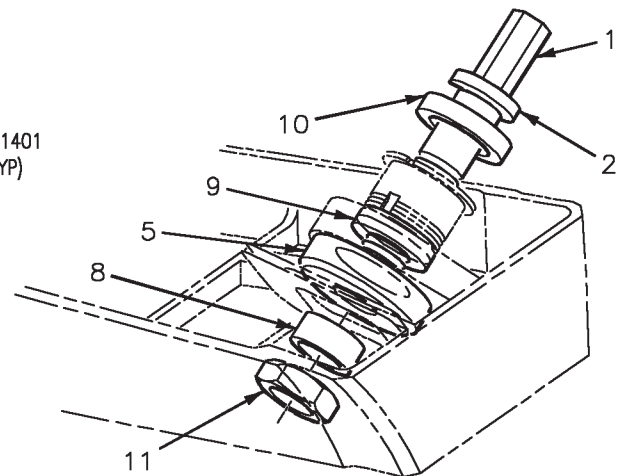
LEGEND

 USE MICROMETER HERE.

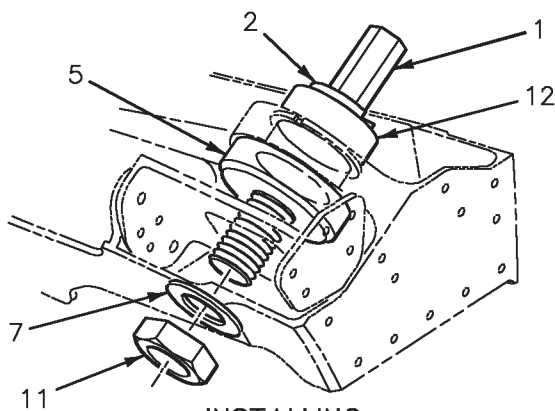
**Figure 3. Working MS14101-12 Bearing in 74A230735 Vertical Stabilizer Lower Rib,
52.5% - 62.5% (Sheet 2)**



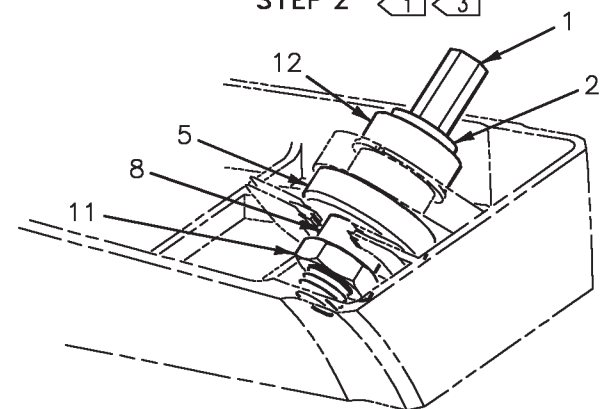
REMOVING
STEP 1 1



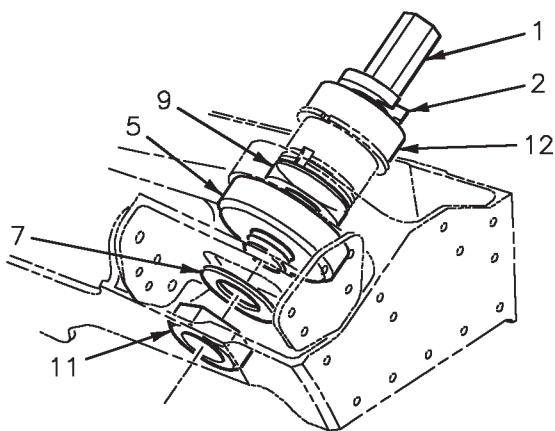
INSTALLING
STEP 2 1 3



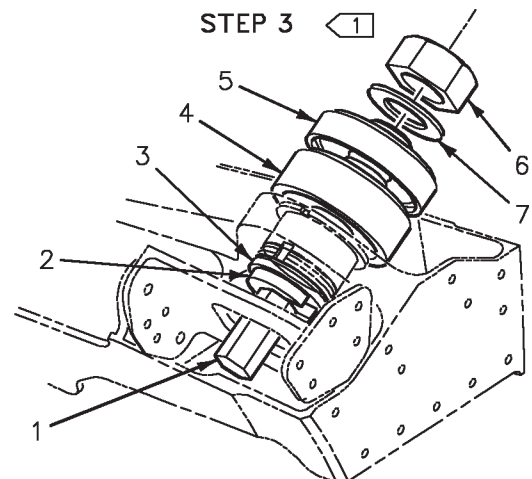
INSTALLING
STEP 6 2



INSTALLING
STEP 3 1



INSTALLING
STEP 5 2 3



REMOVING
STEP 4 2

Figure 4. Working 74B330064 Bearing in 74A331401 Horizontal Stabilator Structural Component Support (Sheet 1)

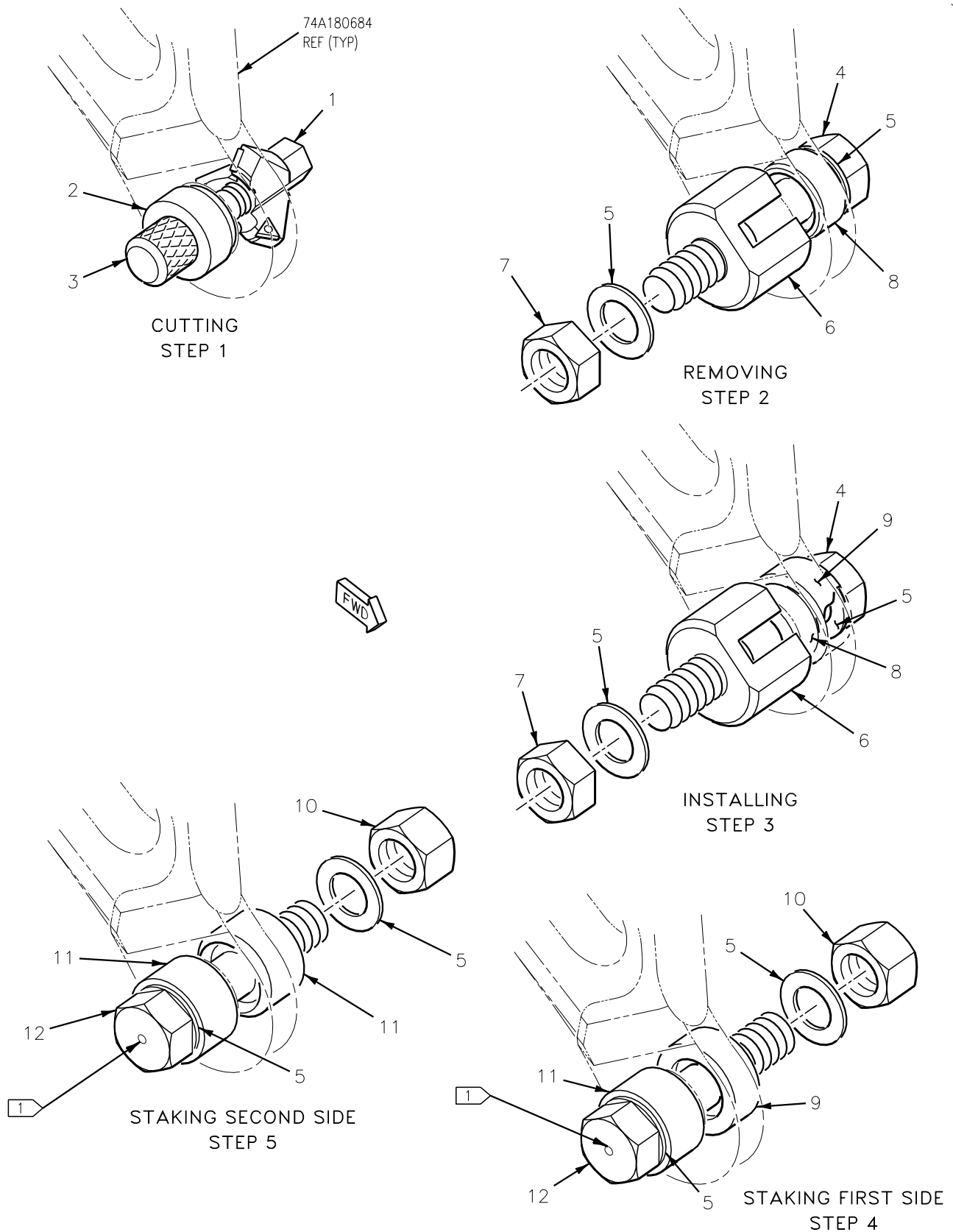
INDEX	NOMENCLATURE	PART NUMBER
1	BOLT	74D111291-2023
2	WASHER	74D111291-2009
3	GUIDE	74D111291-2061
4	HOUSING	74D111291-2057
5	HOUSING	74D111291-2055
6	NUT	AN315-15R
7	WASHER	AN960C1616
8	SPACER	74D111291-2025
9	GUIDE	74D111291-2051
10	PUSHER	74D111291-2059
11	NUT	AN316-18R
12	PUSHER	74D111291-2053

LEGEND

1. STEPS 1, 2, AND 3:
F/A-18A/B 161353 THRU 161761.

2. STEPS 4, 5, AND 6:
F/A-18A/B/C/D 161924 AND UP.

3. PUSH BEARING INTO 74A331401 SUPPORT UNTIL
GUIDE, DETAIL 2051, CONTACTS HOUSING,
DETAIL 2055. REMOVE GUIDE FOR NEXT STEP
OF INSTALLATION.



18AC-SRM-20-(227-1)39-CAT1

Figure 5. Working MS14101-14 Bearing in 74A180684 Trailing Edge Flap Rib Assembly Drive Hinge (Sheet 1)

INDEX	NOMENCLATURE	PART NUMBER
1	CUTTER ASSEMBLY	74D111290-1021
2	ANVIL	74D111290-2069
3	BOLT	74D111290-2055
4	BOLT	74D111291-2049
5	WASHER	AN960C1416
6	HOUSING	74D111291-2043
7	NUT	AN315-14R
8	GUIDE	74D111291-2045
9	PUSHER	74D111291-2047
10	NUT	74D111292-2053
11	ANVIL	74D111292-2037
12	BOLT ASSEMBLY	74D111292-1011

LEGEND

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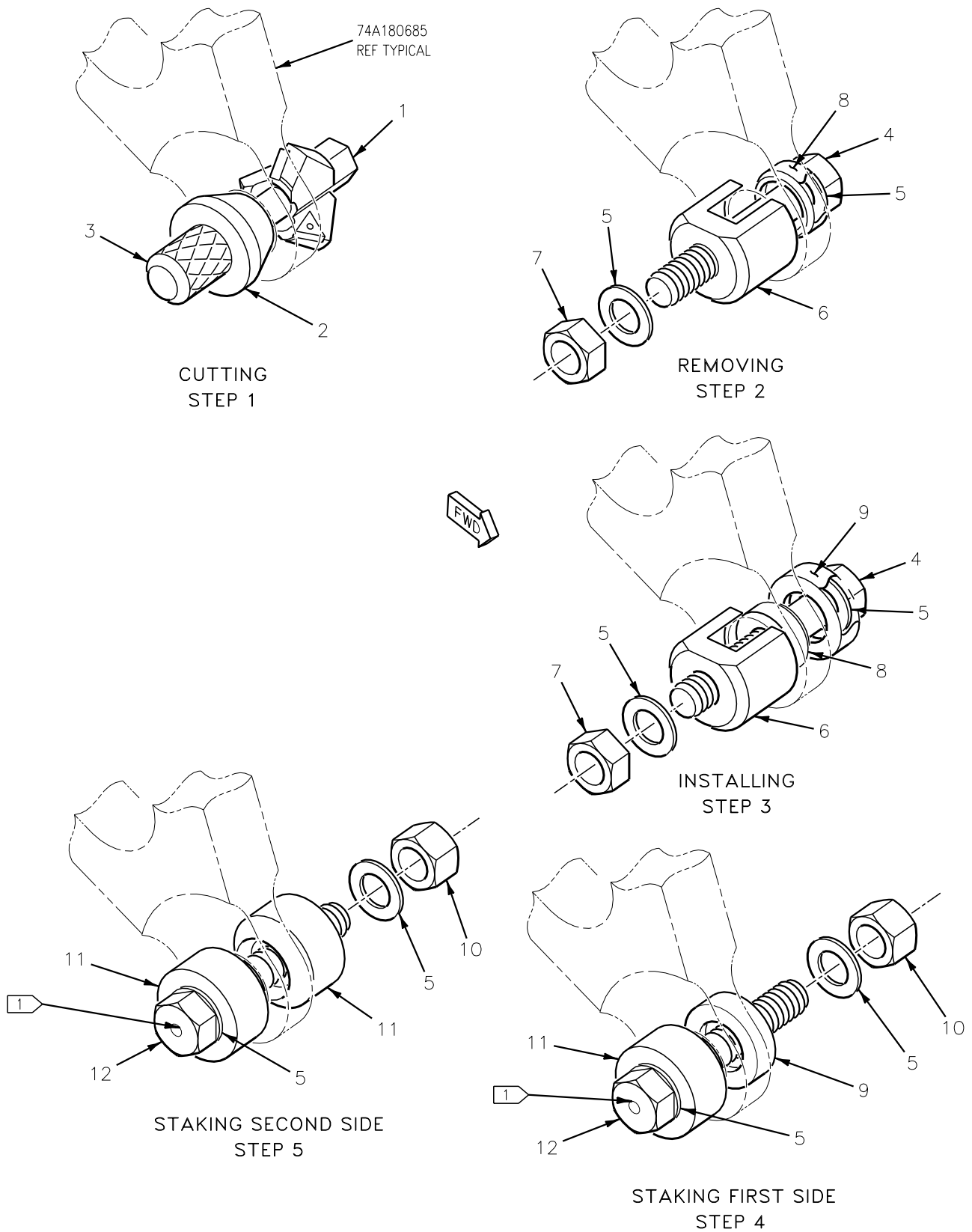
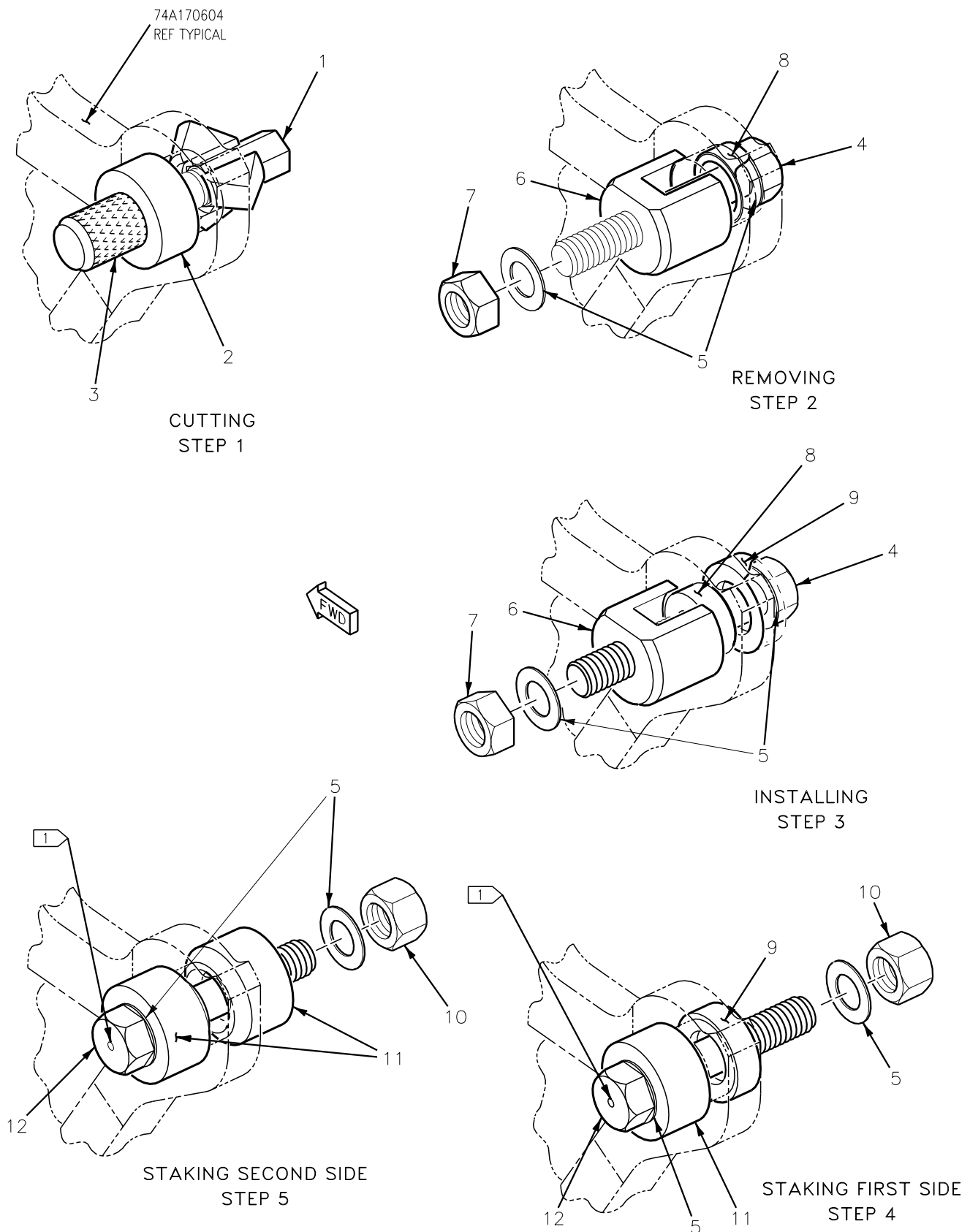


Figure 6. Working MS14103-8 Bearing in 74A180685 Outboard Hinge Trailing Edge Flap Rib (Sheet 1)

INDEX	NOMENCLATURE	PART NUMBER
1	CUTTER ASSEMBLY	74D111290-1009
2	ANVIL	74D111290-2063
3	BOLT	74D111290-2049
4	BOLT	74D111291-2015
5	WASHER	AN960C816
6	HOUSING	74D111291-2017
7	NUT	AN315-8R
8	GUIDE	74D111291-2019
9	PUSHER	74D111291-2021
10	NUT	74D111292-2047
11	ANVIL	74D111292-2019
12	BOLT ASSEMBLY	74D111292-1005

LEGEND

 USE MICROMETER HERE.



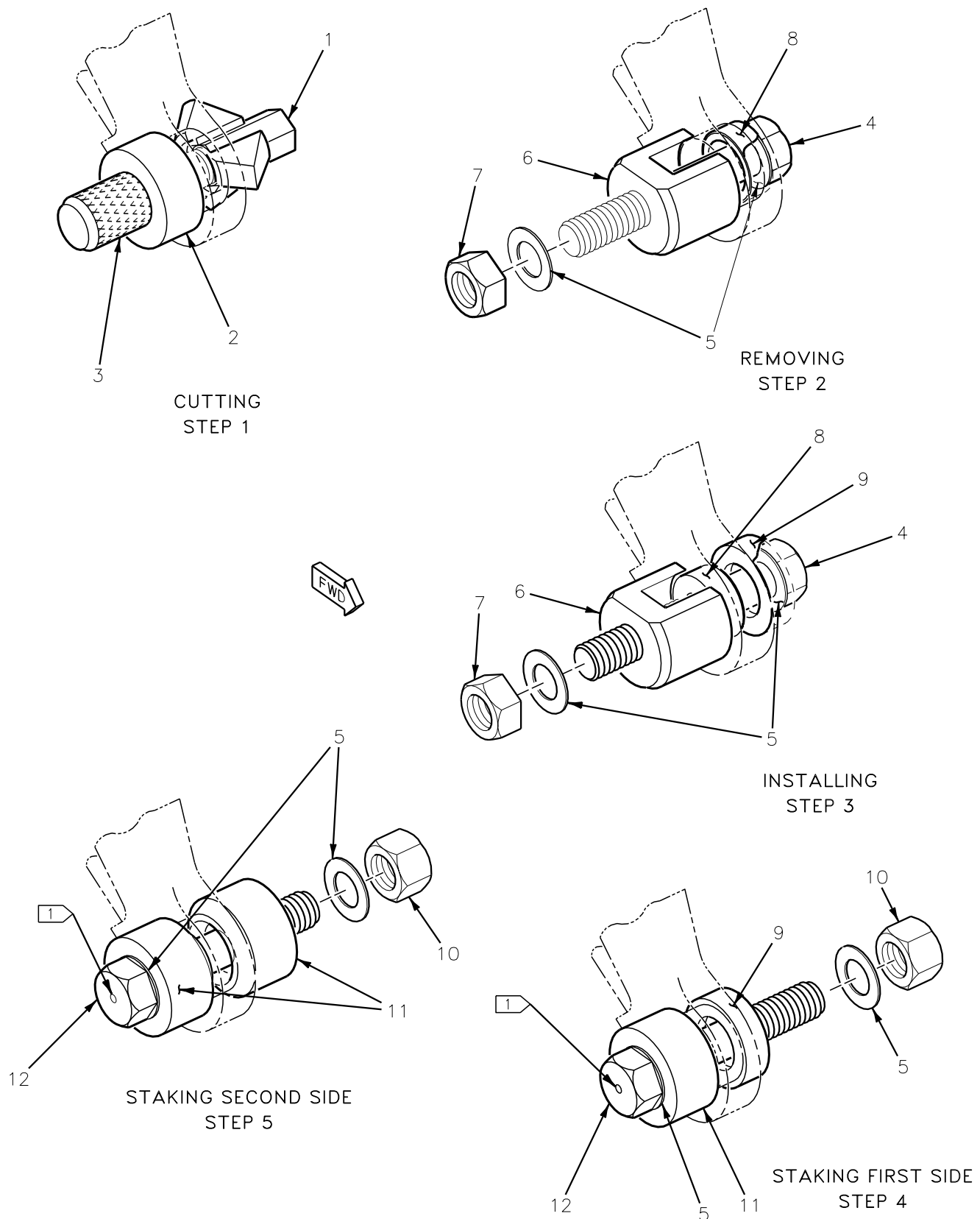
18AC-SRM-20-(229-1)39-CATI

Figure 7. Working MS14103-10 Bearing in 74A170604 Aileron Hinge Inboard Drive Assembly Rib (Sheet 1)

INDEX	NOMENCLATURE	PART NUMBER
1	CUTTER ASSEMBLY	74D111290-1013
2	ANVIL	74D111290-2065
3	BOLT	74D111290-2051
4	BOLT	74D111291-2033
5	WASHER	AN960C1016
6	HOUSING	74D111291-2027
7	NUT	AN315-10R
8	GUIDE	74D111291-2029
9	PUSHER	74D111291-2031
10	NUT	74D111292-2049
11	ANVIL	74D111292-2025
12	BOLT ASSEMBLY	74D111292-1007

LEGEND

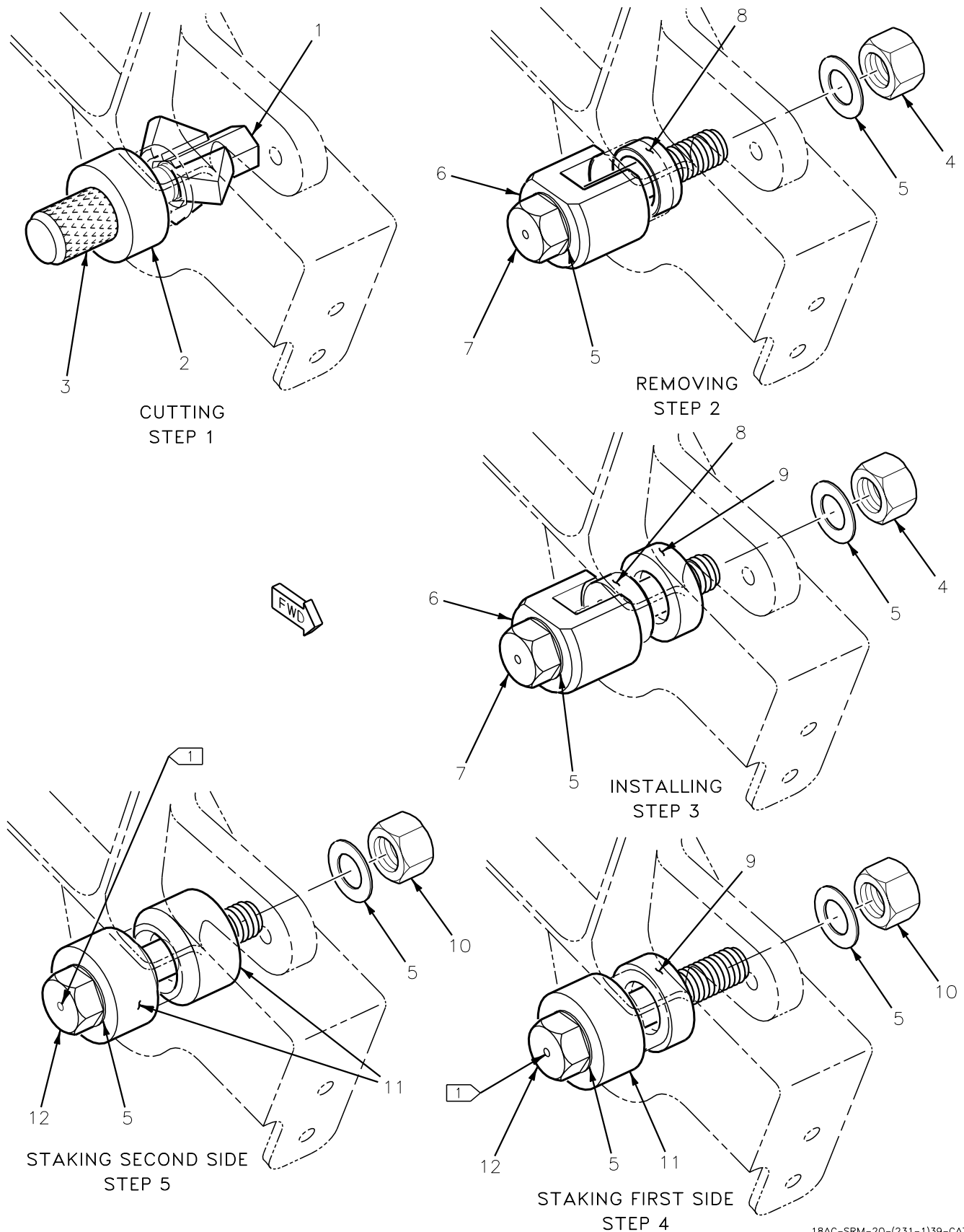
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INDEX	NOMENCLATURE	PART NUMBER
1	CUTTER ASSEMBLY	74D111290-1001
2	ANVIL	74D111290-2059
3	BOLT	74D111290-2045
4	BOLT	74D111291-2007
5	WASHER	AN960C616
6	HOUSING	74D111291-2001
7	NUT	AN315-6R
8	GUIDE	74D111291-2003
9	PUSHER	74D111291-2005
10	NUT	74D111292-2045
11	ANVIL	74D111292-2005
12	BOLT ASSEMBLY	74D111292-1001

LEGEND

 USE MICROMETER HERE.



18AC-SRM-20-(231-1)39-CAT1

Figure 9. Working MS14101-6 Bearing in 74A313027 IFR Probe Actuating Cylinder Support Assembly (Sheet 1)

INDEX	NOMENCLATURE	PART NUMBER
1	CUTTER ASSEMBLY	74D111290-1001
2	ANVIL	74D111290-2059
3	BOLT	74D111290-2045
4	NUT	AN315-6R
5	WASHER	AN960C616
6	HOUSING	74D111291-2001
7	BOLT	74D111291-2007
8	GUIDE	74D111291-2003
9	PUSHER	74D111291-2005
10	NUT	74D111292-2045
11	ANVIL	74D111292-2005
12	BOLT ASSEMBLY	74D111292-1001

LEGEND

 USE MICROMETER HERE.

ORGANIZATIONAL AND INTERMEDIATE MAINTENANCE

STRUCTURE REPAIR

TYPICAL REPAIR

ADHESIVE COMB

PART NO. SK350-00192

Reference Material

None

Alphabetical Index

Subject

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Record of Applicable Technical Directives

None

1. INTRODUCTION.

Materials Required

2. This work package provides information for SK350-00192 Adhesive Comb, see figure 1.

None

Support Equipment Required

None

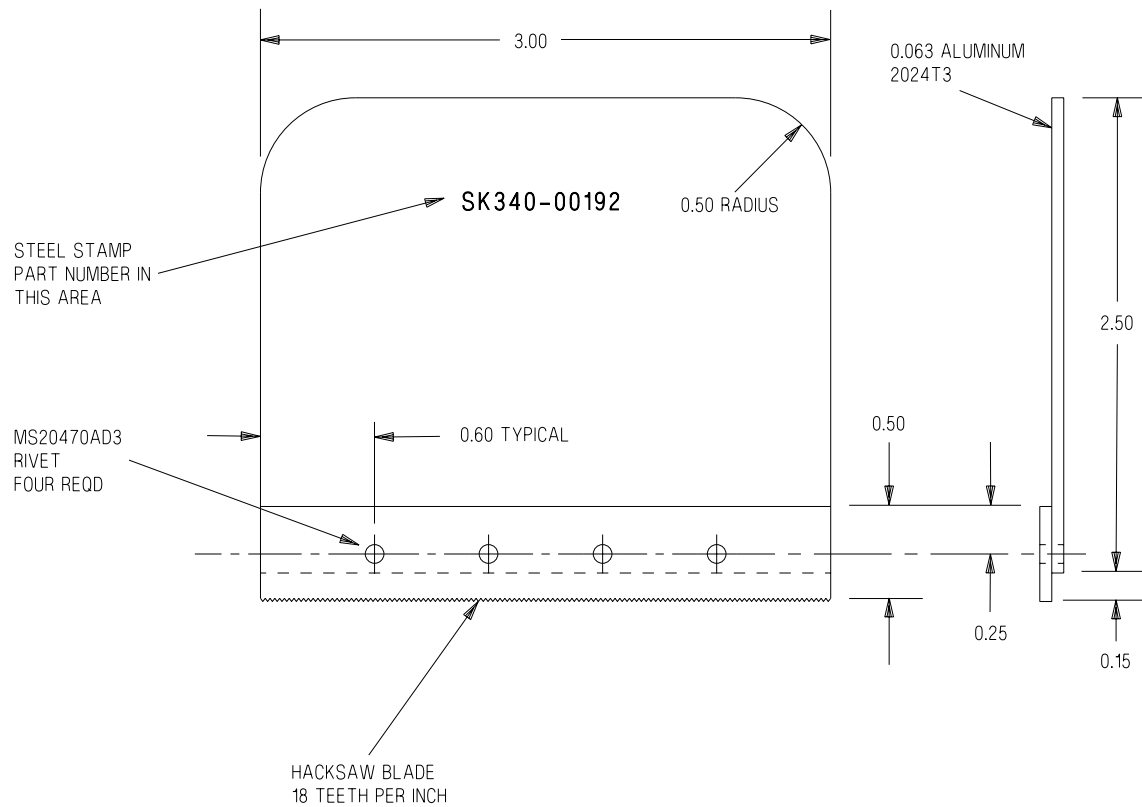


Figure 1. SK350-00192 Adhesive Comb

ORGANIZATIONAL MAINTENANCE

STRUCTURE REPAIR

AIRCRAFT ALIGNMENT

Reference Material

Line Maintenance Procedures..... A1-F18AC-LMM-000

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Record of Applicable Technical Directives

None

1. DESCRIPTION.

2. Forces placed upon aircraft, both in flight or during takeoff and landing, launching or recovery aboard ship, may cause misalignment of the aircraft. Misalignment of aircraft will affect aerodynamic performance. This alignment inspection will aid in maintaining correct aerodynamic performance of aircraft, but should not be used as criteria for finding damage.

3. PROCEDURES.

Support Equipment Required

Part Number or Type Designation	Nomenclature
—	50 Foot Measuring Tape, Metal

Materials Required

Specification or Part Number	Nomenclature
M83953-1 or -2	Aircraft Marking Pencil

4. STRUCTURE ALIGNMENT. See figure 1.

a. Dimensions are taken with aircraft on landing gear, engines installed, fueled or defueled, tip missiles removed or installed, and all pylons removed or installed.

b. Measure and record dimensions of aircraft at points indicated. Compare findings to figure legend. Report findings to local quality assurance.

5. **LANDING GEAR ALIGNMENT.** See figure 2.

a. Have aircraft positioned on jacks with full gear extension (A1-F18AC-LMM-000).

b. Measure and record dimensions of landing gear at points indicated. Compare findings to table 1. Report findings to local quality assurance.

c. Have aircraft removed from jacks (A1-F18AC-LMM-000).

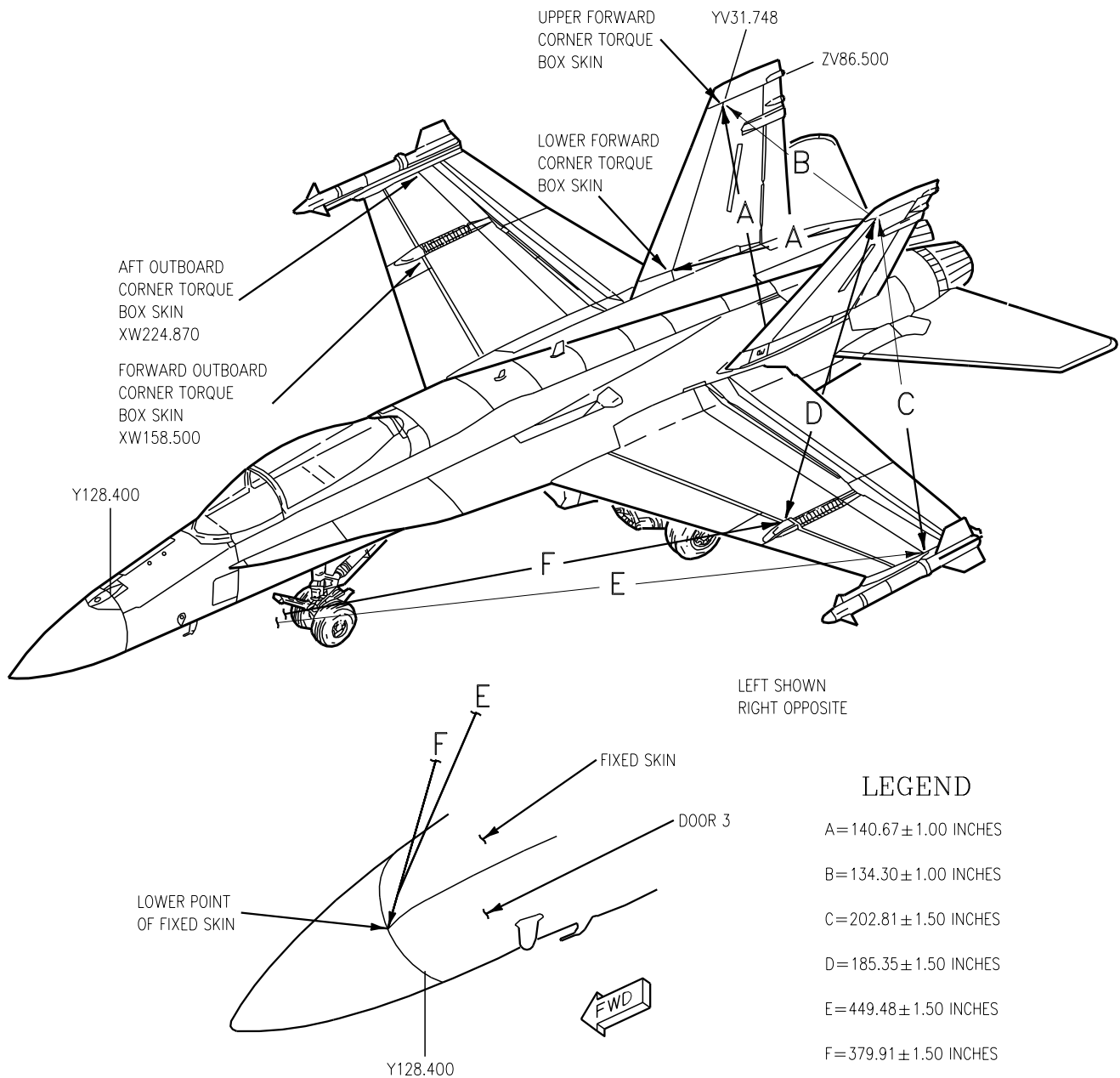
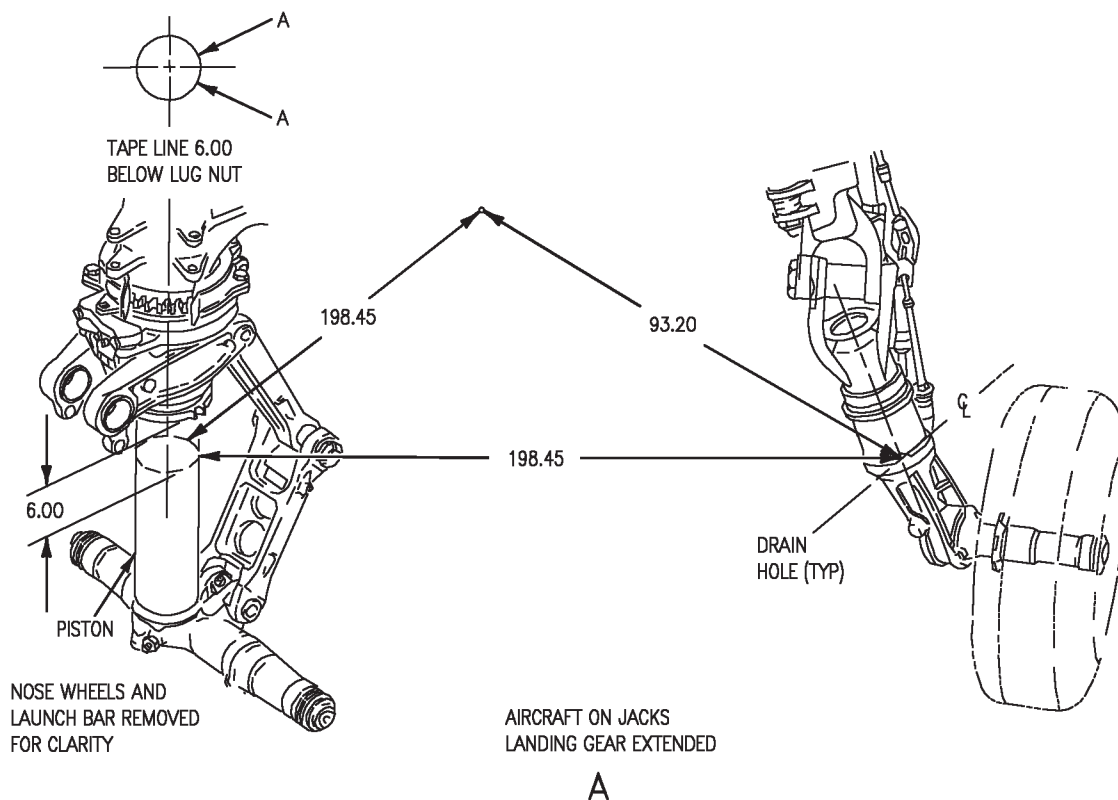
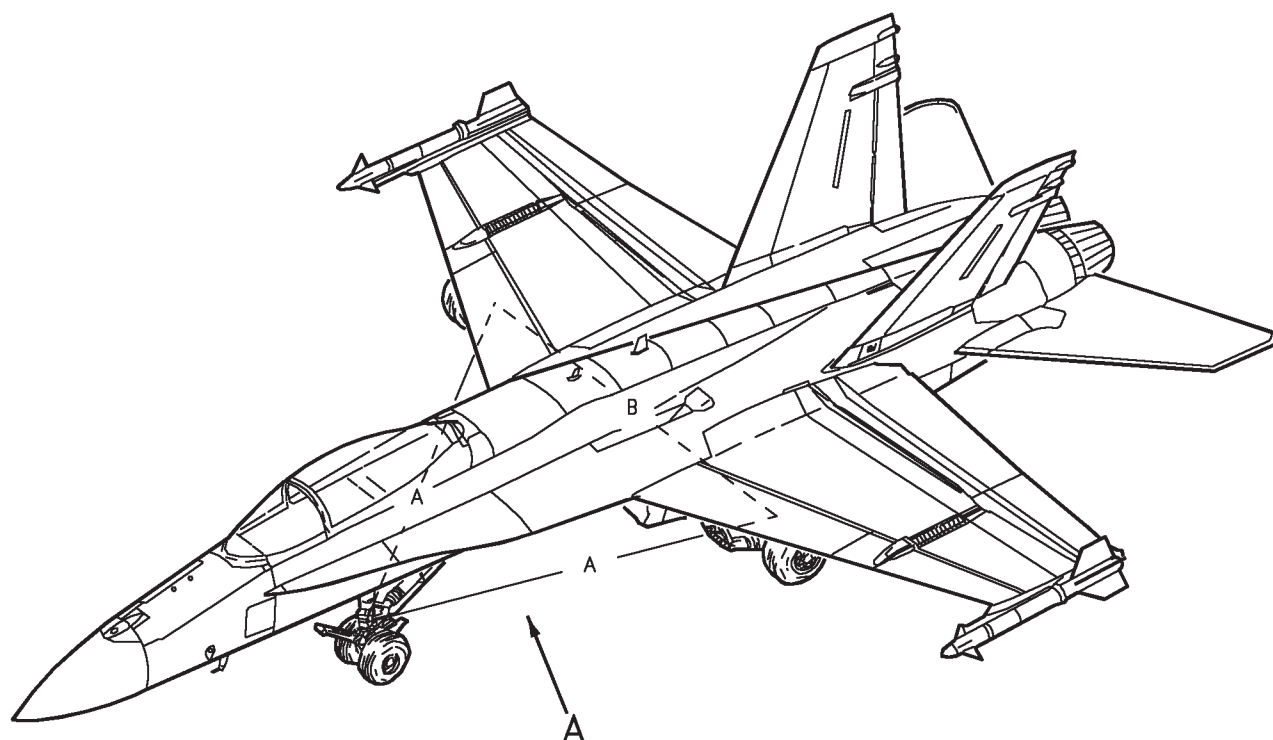



Figure 1. Structure Alignment Dimensions




**Figure 2. Landing Gear Alignment Dimensions
(Sheet 1)**

TABLE 1. LANDING GEAR ALIGNMENT DIMENSIONS AND TOLERANCES

DIM	DIM FOR AIRCRAFT		DIM TOL. BETWEEN LEFT AND RIGHT SIDES OF AIRCRAFT	
	INCHES	FEET AND INCHES	INCHES	INCHES
A	198.45	16'-6-7/16"	2.0	2.0
B	93.20	7'-9-3/16"	1 	

NOTE

1  DIMENSION TOLERANCE BETWEEN MEASURING POINTS IS 1.0 INCH

ORGANIZATIONAL MAINTENANCE

STRUCTURE REPAIR

AIRCRAFT LEVELING

Reference Material

Line Maintenance Procedures..... A1-F18AC-LMM-000

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Servicing	2

Record of Applicable Technical Directives

None

1. INTRODUCTION.

2. High performance aircraft require correct weight and balance. An important part of weight and balance is leveling the aircraft.

3. **LEVELING LUG LOCATION.** See figure 1.

(1) Longitudinal leveling lugs are located on left side of NWW at approximately Y245.00 and Y267.00.

(2) Lateral leveling lugs are located one on left side and one on right side of NWW at approximately Y267.00.

4. **LEVELING PROCEDURES.**

a. Inspect aircraft longitudinal levelness as below:

(1) Put spirit level or inclinometer on longitudinal leveling lugs.

(2) Inflate or deflate main landing gear (MLG) struts/tires (A1-F18AC-LMM-000).

b. Inspect aircraft lateral levelness as below:

(1) Put spirit level or inclinometer on lateral leveling lugs.

(2) Deflate MLG tire on high side (A1-F18AC-LMM-000).

Support Equipment Required

Part Number or Type Designation	Nomenclature
—	24 Inch Spirit Level
—	Inclinometer

Materials Required

None

a. There are three leveling lugs located in the nose wheelwell (NWW).

5. **SERVICING.** Service struts/tires after completion of leveling (A1-F18AC-LMM-000).

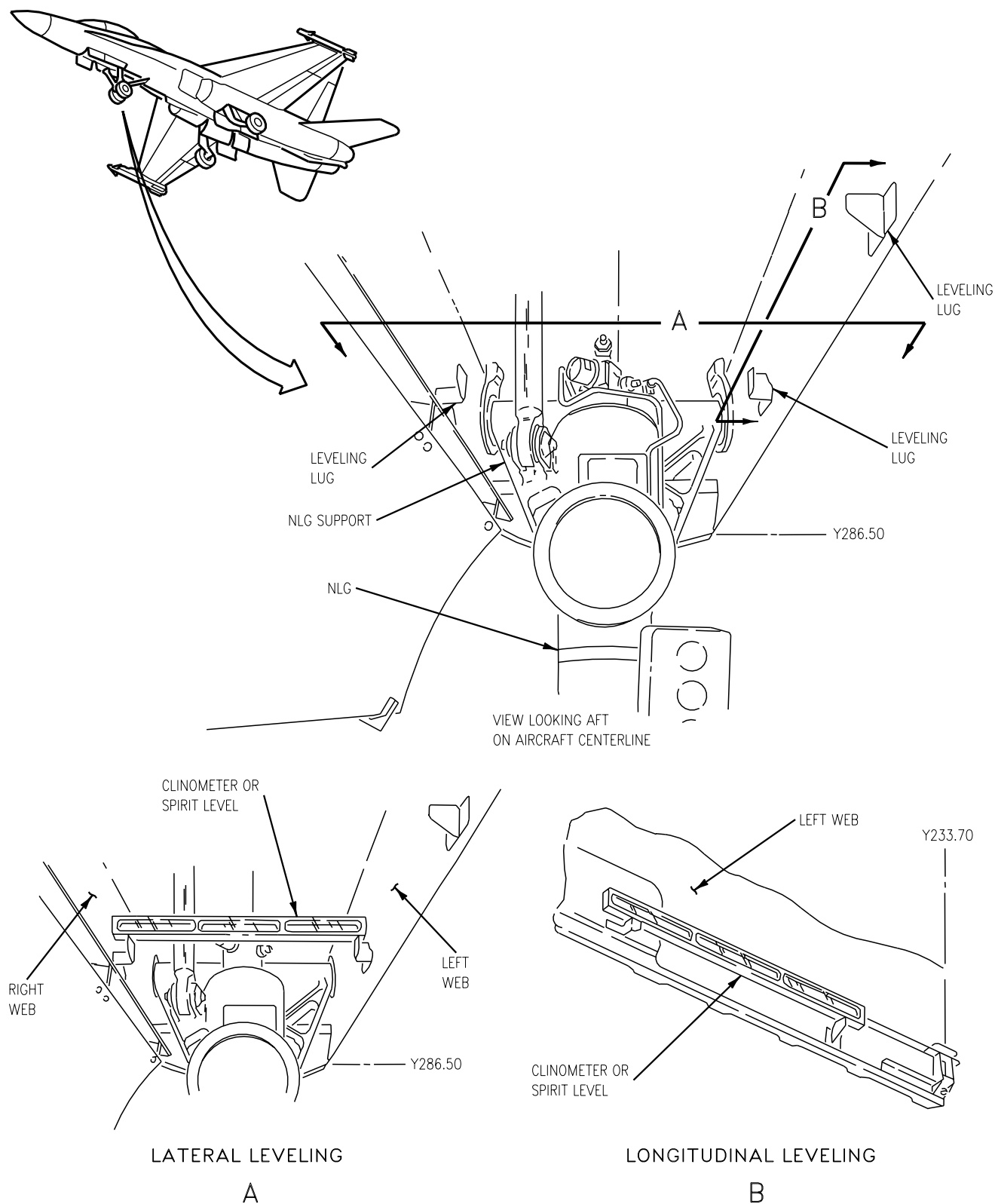


Figure 1. Leveling Lug Location

ORGANIZATIONAL, INTERMEDIATE, AND DEPOT MAINTENANCE**STRUCTURE REPAIR****REPAIR MATERIALS**

Reference Materials

None

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Record of Applicable Technical Directives

None

1. REPAIR MATERIALS.

2. This work package lists materials required to make repairs specified in structure repair series manuals. This work package does not list aircraft corrosion control materials.

3. **SHEET METAL.** See table 1. This table contains sheet metal types used on aircraft. These materials are listed in their final heat treated condition; sheet stock in O, annealed, condition is required for forming operations. In areas of very high temperature, titanium and corrosion resistant steel is used.

4. **CONSUMABLE MATERIALS.** See table 2 for materials used in making repairs, table 3 for materials used in nondestructive inspection, and table 4 for kits containing consumable materials for

repairs. The tables include material, nomenclature, specification or manufacturers part number, and CAGE or procurement source.

5. FASTENERS AND ATTACHING HARDWARE.

Fasteners listed are gang channels, plate nuts, receptacles, close tolerance screws, Jo-Bolts, Olympic-Loks, solid rivets, nuts, bolts, sealing screws, shims, bushings, bearings, retainers, cotter pins, floating barrel nuts, washers, Hi-Loks, Hi-Lok collars, Huck Bolts, sleeves, cherry rivets, lockbolt pins, lockbolt collars, contact strips, fillers, supports, spacers, plates and pins. . Part numbers include military standards, manufacturers number, and where available an equivalent vendor number. Part numbers listed for gang channels are for 6 foot lengths and part numbers listed for electrical bonding strips are for 24 inch lengths. See tables 5 thru 35.

Table 1. Sheet Metal Repair Materials

Alloy	Specification	Usage		
		Extensive	Medium	Low
Alclad:				
2024-0	QQ-A-250/5	0.040, 0.050, 0.063, 0.071	0.090, 0.125, 0.160	0.045, 0.080
	QQ-A-225/8			2.000
2024-T72	QQ-A-250/5	0.040, 0.050, 0.063, 0.071	0.080, 0.090	0.125, 0.160
7075-0	QQ-A-250/12/13	0.032, 0.040, 0.045, 0.050, 0.063	0.071, 0.080, 0.090	0.100, 0.125

Table 1. Sheet Metal Repair Materials (Continued)

Alloy	Specification	Usage		
		Extensive	Medium	Low
7075-T6	QQ-A-250/13	0.032, 0.040, 0.050, 0.063	0.025	0.012, 0.016, 0.020, 0.071, 0.080, 0.090, 0.125
7075-T76	QQ-A-250/25	0.032, 0.040, 0.045, 0.050, 0.063	0.080, 0.090, 0.100	0.125, 0.160, 0.190
7075-T651	(QQ-A-250/12 or 14)			0.035
7075-T76511	QQ-A-250/25		0.080, 0.090	
Al Aly:				
2024-0	QQ-A-250/14	0.032, 0.040, 0.050, 0.063, 0.071, 0.080, 0.100	0.090	0.025, 0.036, 0.062, 0.125
2024-T72	QQ-A-250/14	0.040, 0.050	0.063	0.071, 0.080, 0.090, 0.125
6061-0	QQ-A-250/11			0.020, 0.032, 0.051, 0.063
6061-T6	QQ-A-250/11			0.025, 0.032, 0.040, 0.063, 0.071
7075-0	QQ-A-250/12	0.040, 0.050	0.032, 0.063, 0.071	0.025, 0.080, 0.090, 0.125
7075-T6	QQ-A-250/12	0.040, 0.050	0.063, 0.071	0.012, 0.020, 0.025, 0.030, 0.080, 0.090
Titanium:				
Unalloyed	MIL-T-9046, Type 1, Comp. B, Anl			0.008, 0.010, 0.012
6 Al-4V Anl	MIL-T-9046, Type 3, Comp. C, Anl	0.032, 0.036, 0.040, 0.050, 0.056, 0.063, 0.071, 0.090, 0.112, 0.125, 0.140	0.063, 0.080, 0.090 0.100	0.008, 0.012, 0.016, 0.020, 0.025, 0.160, 0.190
Copper:				
Annealed Copper	QQ-C-576			0.020

Table 1. Sheet Metal Repair Materials (Continued)

Alloy	Specification	Usage		
		Extensive	Medium	Low
Copper, ETP	QQ-C-576			0.020
Copper	QQ-C-516			0.020
Corrosion resistant steel:				
302 Anl	MIL-S-5059			0.025, 0.050
321 Anl	AMS-5510		0.050, 0.100, 0.125	
A-286	AMS-5737			0.090
17-7PH	MIL-S-25043			0.020
Steel:				
301	MIL-S-5059			0.050, 0.100
1/2 or 1/4 Hard				

Table 2. Consumable Materials for Repairs

Nomenclature	Specification No. or Manufacturers No.	CAGE or Procurement Source
Abrasive Cloth, Polysand, Grit No. 1500, 1800, 2400, 3200, 3600, 4000, 6000, 8000, 12000	1500MICRO-MESH 1800MICRO-MESH 2400MICRO-MESH 3200MICRO-MESH 3600MICRO-MESH 4000MICRO-MESH 6000MICRO-MESH 8000MICRO-MESH 12000MICRO-MESH	32834 32834 32834 32834 32834 32834 32834 32834 32834
Abrasive Grain, Material For Blasting, Aluminum Oxide	MIL-A-21380, TYPE 1, GRIT 120 and 220	81349
Abrasive Mat, Non Woven, Non Metallic, Fine and Very Fine, 0.25 Thick	MILA9962TY1CL1GRBX9X11 or MILA9962TY1CL1GRAX9X11	81349

Table 2. Consumable Materials for Repairs (Continued)

Nomenclature	Specification No. or Manufacturers No.	CAGE or Procurement Source
Abrasive Paper, Silicone Carbide, Waterproof	A-A-1047 GRIT 120 - 9X11	58536
	A-A-1047 GRIT 150 - 9X11	58536
	A-A-1047 GRIT 180 - 9X11	58536
	A-A-1047 GRIT 240 - 9X11	58536
	A-A-1047 GRIT 280 - 9X11	58536
	A-A-1047 GRIT 320 - 9X11	58536
	A-A-1047 GRIT 400 - 9X11	58536
	A-A-1047 GRIT 600 - 9X11	58536
Acetone, Technical	O-A-51	81348
Acoustic Blanket	74A800812	76301
Acid Swab Brush	H-B-643, TYPE 2, CLASS 1, SIZE 1	81348
Adhesion Promoter	NO. 86	52152
Adhesive	EA934	33564
Adhesive	MMM-A-132 TY1CL3	80244
Adhesive	EA956	33564
Adhesive	EA9321 A/B	33564
Adhesive	EC847	04963
Adhesive	EC-776	04963
Adhesive, Liquid Shim	EA9317A/B	33564
Adhesive	R35	55913
Adhesive	EC1357	04963
Adhesive	EC2216 A/B	04963
Adhesive	ECCOBOND64C	04552
Adhesive	EPON828	86961
Adhesive	EA9309A/B	33564
Adhesive, Clear	SILASTIC 732 RTV	71984
Adhesive	RTV732BLACK	71984

Table 2. Consumable Materials for Repairs (Continued)

Nomenclature	Specification No. or Manufacturers No.	CAGE or Procurement Source
Adhesive	RTV106	01139
Adhesive	RTV3145 RTV GRAY	71984
Adhesive, Film	FM300	07542
Adhesive Film, Core Splice Adhesive Foam	FM404	07542
Adhesive Film	FM73	07542
Adhesive Film, Verifilm	FM641	07542
Adhesive Compound, Aerodynamic Filler	EA960F	33564
Adhesive Tape, Sealant Tape, Pressure Sensitive, Vacuum Bag Tape	9151-0-500	53309
Aircraft Grease	MIL-G-81322	81349
Aircraft Marking Pencil	M83953-1 or -2, MIL-P-83953-2	81349
Anti- Static Cream	3MASC8	32834
Aluminum Alloy Bar Stock, 7075-T7351, 0.375 X 0.750 X 0.820	QQ-A-225/9	81348
Aluminum Foil Tape, Two Inches Wide, Pressure Sensitive Tape	Y427	04963
Aluminum Honeycomb Core, Nonperforated	8-1-1-8-0-002N5056-4-5, 0.125 INCH CELL, 0.002 INCH THICK FOIL	07542
Aluminum Laminate, Shim Stock 0.048 X 0.95 X 1.92	MIL-S-22499, CLASS 2, TYPE 1, COMP 1	81349
Aluminum Oxide Abrasive Cloth	AA1048TY1CL1GRIT80X9X11 AA1048TY1CL1GRIT240X9X11 AA1048TY1CL1GRIT320X9X11 AA1048TY1CL1GRIT400X9X11 AA1048TY1CL1GRIT600X9X11	58536 58536 58536 58536 58536
Aluminum Plate, 0.250 X 2.000 X 2.000	QQ-A-250/12	81349

Table 2. Consumable Materials for Repairs (Continued)

Nomenclature	Specification No. or Manufacturers No.	CAGE or Procurement Source
Aluminum Plate, 2 X 47 X 3/4, 6061	QQ-A-250-11COND T651-0-750	81348
Aluminum Plate, 4 X 4 X 1/2, 6061	QQ-A-250-11COND T651-0-500	81348
Alloy Steel, Bar and Rod A-286	AMS5737	81349
Artists Brush	H-B-118 TY3CL2STCSZ1/2	81348
Assorted Pencils, Marking Pencil	SS-P-201 TYPE1 CLASSB	81348 or 11581
Automobile Wax	P-W-120 TY1	81348
Barrier Material	MIL-B-121 TY1GRACL1	81349
Barrier Material, Water Vapor- proof, Flexible, Heat Sealable	MIL-B-131, CLASS 1	81349
Blind Rivet	M7885/2-5-3 M7885/3-6-3 M7885/3-6-4 M7885/3-6-5	81349 81349 81349 81349
Block	74R092027-2019	76301
Boot, Nose Cone	SJ-8665FP-44	76301
Brush, Tooth Brush	H-T-560 TYPE 1 STYLE B	81348
Bushing Material	AMS5629 - H1000 PH13-8M0	81349
Bushing Material	AMS5643-H1025, PH17-4	81349
Cap, Protective	MS90376	96906
Camel Hair Brush	COMMERCIAL	81348
Cartridge Assembly, Polyethylene Cartridge, 6 oz. With Plunger	220325	92108
Cartridge Assembly, Sealing Gun Cartridge	250-CP2-1/2	92108
Cartridge, Sealing gun	220329	92108 or 80244
Cartridge, Sealing gun	220323	92108

Table 2. Consumable Materials for Repairs (Continued)

Nomenclature	Specification No. or Manufacturers No.	CAGE or Procurement Source
Cartridge Adapter Kit	226358	92108
Caulking Nozzle, Sem-Luer Adapter	231871	92108
Caulking Nozzle, Sem - Needle	231843	92108
Caulking Nozzle, Sem - Needle	231845	92108
Caulking Nozzle, Sem - Needle	231844	92108
Caulking Nozzle, Injection Nozzle	TBM-1-8-12	27661
C-Clamp, 6 Inch	COMMERCIAL	81348
Cheesecloth	CCC-C-440 TYPE 1 CLASS 1	81348
Chemical Gloves, Rubber Gloves	ZZ-G-381, TYPE 1, STYLE 1, SMALL, MEDIUM, and LARGE	81348
Cleaning Cloth, Rymplecloth	RYMPLE CLOTH- 301-PURIFIED	97327
Cleaning Compound	020X413	85570
Cleaning Compound	30401720	94058
Cleaning Compound	5772 048	0YG51
Cleaning Compound	SHOPMASTER LPH	0YG51
Cleaning Compound, Cleaner Alkaline Rust Remover, Cleaner Additive	4215S	61102
Cleaning Compound, Cleaning Solvent for Electrical Components	MMS409	76301
Cleaning Compound, Engine Gas Patch	BANDB3100	21361
Cleaning Compound, Metal Solvent	MIL-C-38736	81349
Cleaning Compound	TURCO 4316	61102
Cleaning Compound	TURCO 4367	61102

Table 2. Consumable Materials for Repairs (Continued)

Nomenclature	Specification No. or Manufacturers No.	CAGE or Procurement Source
Cleaning Compound, Aircraft Surface	MIL-C-85570	81349
Cleaning Cloth, Non Woven Fabric	CCC-C-46, TYPE 1, CLASS 4	81348
Cleaning Cloth	MIL-C-87962, TYPE 1	81349
Clip, High Carbon Spring Steel	74A802620-2039	76301
Cloth Impregnated, Silicone Rubber Impregnated Fabric	CS-4202	86281
Cloth Netting, Nylon Cloth, Scrim Cloth	PATTERN 30	92835 (2G749)
Coated Cloth, Peel Ply, Release Fabric	BLEEDER LEASE A or E	53912
Conductive Coating	E-KOTE 3064 / 3073	70103
Copper, Beryllium 1.125 Inch Rod	QQ-C-530, CONDITION A	81348
Copper, Beryllium 1.0 Plate	QQ-C-530, CONDITION A	81348
Copper, Beryllium Bar	QQ-C-539, CONDITION A	81348
Corrosion Resistant Compound, Chemical Conversion Material, Used on Aluminum and Aluminum Alloys	MIL-C-81706 CLASS 1A FORM 3	81349
Corrosion Prevention Compound	MIL-C-16173, GRADE 2 or GR4	81349/80244
Corrosion Preventive	MIL-C-85054 TY1	80244
Corrosion Prevention Compound, Rust Preventive Compound	TECTYL 477D	72527/80244
Corrosion Resistant Compound	MIL-C-5541, CLASS 1A	81349
Cover Assembly	74A350865-1001, -1002	76301
Coherent Absorbent, Rubber Sheet	9417A	54320
Connector, Electric Plug	MS3101R16-10P	81349

Table 2. Consumable Materials for Repairs (Continued)

Nomenclature	Specification No. or Manufacturers No.	CAGE or Procurement Source
Copper Tape, Conductor Through Adhesive, Pressure Sensitive Tape	1245	26066 or 76301
Core Material, Overexpanded Nomex Core, 0.250 Inch Thick	MMS-715, TYPE 3	76301
Corrosion Preventive Coating for Aircraft Integral Fuel Tanks	MIL-C-27725 TY2CLB	81349
Cushioning Material, Foam Block	PPP-C-1752, TYPE 1	81348
Cutting Fluid, Liquid Coolant	ISOPAR M	29700
De-ionized Water	COMMERCIAL	81349
Desiccants, Activator	MIL-D-3464, TYPE 1	81349
Dielectric Coolant Fluid, Insulating Oil	MIL-C-47220TYPEIV	81349
Disposable Applicator, Cotton Swabs, Q Tips	6-143	89875
Distilled Water	DISTILLEDWATERCOM-MERICAL	81348
Dope Thinner	A-A-857	58536
Drain Adapter	74A315044-1005, -1006	76301
Dry Cleaning Solvent	P-D-680, TYPE 2	81348
Dry Chemical, Fire Extinguishing Powder, (Sodium Bicarbonate, Dry)	PURPLE K-50LB	03670 81348
Dry Film Lubricant, Lubricant, Solid	MIL-L-46147 TY2	81349
Dry Film Lubricant, Lubricant Solid	620C EVERLUBE MIL-L-8937, FORM A	81349
Dry Woven Graphite Cloth, Satin Weave, 8 Hardness 24 X 23 Construction; (Repair Cloth for MMS-544, Type 1)	W-133	07314

Table 2. Consumable Materials for Repairs (Continued)

Nomenclature	Specification No. or Manufacturers No.	CAGE or Procurement Source
Dry Woven Graphite Cloth, Satin Weave, 8 Hardness, 21.5 ±1 Construction, Qualified Fiber AS4W-3K. Repair Cloth for MMS-544, Type 1, Grade A.	A370-8H	10396
Dry Woven Graphite Cloth, Satin Weave, 8 Hardness 24 × 23 Construction	MMS-544	76301
Edging Strip	74A350635-2001, -2003	76301
	74A350635-2005	76301
Electrical Bonding Contact Strip, EMI, 0.125 Offset	ST9M622-2-()	76301
	ST9M622-3()	76301
	ST9M622-3-2400	76301
	ST9M622-4-()	76301 or 52814
	ST9M622-5-()	30817 or 52814
	ST9M622-6-()	30817
EMI Seal	11M1022-1	76301
	11M967-1	76301
	74A200947-2033	76301
	74A200947-2035	76301
	74A200947-2037	76301
	74A200947-2039	76301
Epoxy Primer Coating	MIL-P-23377 TY1	80244
Ethyl Foam, 0.375 Thick Cushioning Material, Resilient Low Density Unicellular Polypropylene Foam	PPP-C-1752, TYPE 1	81348
Eyebolt	AN48-22	88044

Table 2. Consumable Materials for Repairs (Continued)

Nomenclature	Specification No. or Manufacturers No.	CAGE or Procurement Source
Eyebolt	COMMERCIAL	81348
Eye Bolt	123485-1	81348
Extrusion, For 74A190677-2001 Thru 2006	1MA120D06-10308	76301
Extrusion, For 74A110866-3759, NYLON 6/6 L-P-410 NATURAL	14M201-1	76301
Extrusion, For 74A190677-2007 Thru 2012	1MA120D06-10309	76301
Extrusion, For 74A190677-2013, -2014, -2017, -2018	1MA100D06-10375	76301
Extrusion, For 74A190677-2015, -2016, -2019, -2020	1MA100D06-10375	76301
Extrusion, Nylon	14M201-1	76301
Fabricut, Wet-or-Dry Sanding Screen	400	28124
Face Shield	MIL-STD-1202	81349
Felt Pad, 0.500 Inch Thick	COMMERCIAL	81348
Fiberglass Cloth, Epoxy Inpreg- nated.	MMS-529TYPE1	76301
Fibrous Rope, Manila Rope, 1/2- Inch	T-R-605TYPEM, CLASS 2 SIZE1-1/2IN.	81348
Filler Material	No. 10/20GROUNDCORK	27661
Filler Material	CRUSHEDVYCOR7900, CRUSHED CORK	14674
Filler Material, Ground Filler, Flat Glass Filler	VYCOR 7913	14674
Filler Material, Welding Rod	CRES347	81349
Filler Material, Welding Rod	6Al-4V	81349
Film, Mylar, Polyester	MYLAR-TYPE A, 0.00142TH	18873

Table 2. Consumable Materials for Repairs (Continued)

Nomenclature	Specification No. or Manufacturers No.	CAGE or Procurement Source
Flannel Cloth	CCC-C-458, TYPE 3, CLASS 2	81348
Flush Head Steel Bolts, 0.750 × 9.00 Inches	COMMERCIAL	81348
Foam	SCOTTFELT 5-650	78112
Form in Place Doughnut (FIP)	IES-685, 0.25	OK555
Gang Channel	MS21065-3-7-3 or MS21065-3-7-2	96906
Glass Bubbles	A20/1000	04963
Glass Floc, 1/32-Inch Milled Glass Fibers	COMMERCIAL	12760 / 81348
Glass Roving, Fiberglas	410AA450TYPE30 or 475BA450,TYPE30	45255 45255
Graphite Epoxy Patches	18AC-SRM-G/E -1001 thru -1021	Fabricate: (A1-F18AC-SRM-250, WP006 00)
Graphite Epoxy Pre-preg, 12 Inches Wide, 0.0052 Thick, FIBERGLAS Cloth	MMS549TYPE1	76301
Heat Transfer Fluid	C00LAN0L45R	76541
Hinge Half	74A360209-1003/-1004	76301
Honeycomb Core, Nonperforated	MMS-714, HRH-10-1/4- 3.0-0X	51344
Hydrofluoric Acid	O-H-795	81348
Hypodermic Syringe, No. 15	GG-N-196	81348
Industrial Tape, 1 Inch Wide, Permacel, Olive Drab	P-691-1INOD	99742
Industrial Wire Fabric, Wire Cloth, 304 CRES 0.125	RR-W-360, CLASS 1, TYPE 1	81348
Industrial Wire Fabric, Wire Cloth, 304 Stainless Steel Screen, 0.125 Grid, 0.020 And 0.025 Wire	RR-W-360, CLASS 1, TYPE 1	81348
Insulation Blanket	74A835789-2157	76301

Table 2. Consumable Materials for Repairs (Continued)

Nomenclature	Specification No. or Manufacturers No.	CAGE or Procurement Source
Insulation Blanket	BL 14761-4	92798
Insulation Tape, Pressure Sensitive, High Temperature, 1/2 or 1-Inch Wide	MIL-I-19166, 1.000IN.WIDE AND 1/2IN.	81349
Isopropyl Alcohol	TT-I-735 GRADE B	81348
Jumper	MS25083-5BC12	81349
Laminated Washer	4M38A616L	76301
Laminating System	RP1720 AUTO-LAM	02684
Laminating System, Quickset Plastic	RP1710	02684
Laundry Net, Nylon Net Bag	JJ-N-180, TYPE 1, STYLE A, SIZE 2	81348
Leather Gloves	MIL-G-43411	81349
Lens Cloth	73	81349
Litmus Paper, Acs	MS36253-3	96906
Lockwire	MS20995-NC20 MS20995-NC32	96906
Lockwire	MS20995N40	96906
Lockwire	MS20995N51	96906
Lubricant, Fluorecarbon	D-5440NS	8E913
Lubricating Oil	VV-L-800	81348
Lubricating Oil	MIL-L-7808	81349
Mask, Air Filtering	RR-C-430	81348
Masking Disk	APSV331- 0.032-0.040 OD	OK555 or 76301
Masking Washer	IES-685-104	OK555 or 76301
Masking Disk	APSV331-0.032-0.050 OD	OK555 or 76301
Masonite, 0.125 Inch	COMMERCIAL	81348

Table 2. Consumable Materials for Repairs (Continued)

Nomenclature	Specification No. or Manufacturers No.	CAGE or Procurement Source
Metal Can, 6 oz.	No. H016	81348
Mens Gloves, Cotton Work Gloves	MIL-G-3866, TYPE 1, SMALL and MEDIUM	81349
Metal Cleaner, Aluminum Clean- ing Material	222555	92108
Metal Cleaner, Titanium Cleaning Material	PASA-JELL 107	92108
Metal Spatula, Tongue Depressor	GG-D-223	81348
Methanol, Technical	O-M-232	81348
Molybdenum Disulfide	MIL-M-7866	81349
Methyl Ethyl Ketone	TT-M-261	81348
Methyl Isobutyl Ketone	D 1153	81346
Micro-Gloss, Abrasive Cream	3MG8	32843
Nitric Acid, Technical	O-N-350	81348
Nitrogen, Technical, Liquid	BB-N-411 TYPE 2 CLASS 1 GRADE B	81348
Nylon Plug	DP-()	76301
Nylon Button Plug	ST9M621-500	76301 or 28520
Operating Cap, Protective	MIL-C-37015	81349
Cleaning Solution, Optical Cleaner	MIR-O-LEN	96448
Aliphatic Polyurethane Enamel, FED-STD-595, Color No. 36320, Gray	MIL- C-83286 TYPE1	81349
Aliphatic Polyurethane Enamel, FED-STD-595, Color No. 17925, White	MIL- C-83286 TYPE1	81349
Paint Remover, Epoxy System	MIL-R-81294 TY1	81349 or 80244

Table 2. Consumable Materials for Repairs (Continued)

Nomenclature	Specification No. or Manufacturers No.	CAGE or Procurement Source
Paper Cup, Waxfree, 16 oz.	UU-C-806 TYPE 1 STYLE A CLASS 1	81348
Paper Cup, Waxfree, 8 oz.	UU-C-806 TYPE 2 STYLE A CLASS 1	81348
Parting Agent	RP804 PVA	02684
Petrolatum, Technical	VV-P-236	81348
Phenolic Compound, Phenolic Microballoons	BJ0-0930	87578
Pin, Spring, Tubular Slotted	MS16562-17	96906
Pin, Spring, Tubular Slotted, Oversized For MS16562-17	MS16562-27	96906
Plain Weave Cloth, Satin Cloth, Glass, Finished For Resin Lami- nates; Glass Fabric Breather Cloth, 10 Mil or 5 Mil	MIL-C-9084 TYPES 3, 8, 8A, 8B, 12 or 12A CLASS 2	81349
Plaster, Gypsum	HYDROCAL B-11	61357
Plastic Film, Tedlar Film, 1 Mil and 2 Mil Thick	100SG30TR and 200SG40TR	18873
Plastic Polish	P-P-560 TY1	81348 or 80244
Plastic Sheet, 0.100 Thick	LP410	81348
Plastic Sheet	AF-100 A	31708
Plastic Sheet	LP410 NYLON 6/6	81348
Plastic Sheet	DELRIN 100AF	31708
Plastic Sheet	L-P-513-T4-PBG-0.875	81348
Plastic Sheet, Insulation Sheet	MIL-P-18177, TYPE GEE0 -250X37X49	81349
Plastic Sheet, Nylon Film, 2 Mils Thick	WRIGHTLON 7400	01697
Plate	74A330754	76301

Table 2. Consumable Materials for Repairs (Continued)

Nomenclature	Specification No. or Manufacturers No.	CAGE or Procurement Source
Polyamide Resin	VERSAMID125	11884
Polyurethane Cap For Metal Can	7797	81348
Polyurethane Coat, Color; Gray	MIL-C-83286, TYPE 1	81349
Polyurethane Coating	MIL-C-85285, TYPE 1, 17925	81349
Polyurethylene Foam or Polyurethane Foam	PR850 STEPANFOAM P-506	83574 87570
Polyethylene Film Sheet, Plastic Sheet, 6 Mil (3 to 5 Mil)	L-P-38, TYPE 1, CLASS 1 GRADE B	81348
Polyethylene Foam, Cushioning Material	PPPC1752TY1CL2-4-00X12X108	81348
Polyester Felt	COMMERCIAL	81348
Polyester Thread	V-T-285-D	81348
Preformed Packing	SZ7583-8	95272
Preformed Packing	SZ7583-10	95272
Preformed Packing	SZ7583-12	95272
Preformed Packing	SZ7583-14	95272
Pressure Sensitive Tape, Graphite Epoxy Pre-preg. 12 Inches Wide, 0.052 Thick	MMS549TYPE1	76301
Pressure Sensitive Tape, Double Coated Adhesive Tape	A-A-180, TYPE 2, GRADE B, 0.500 IN	58536
Pressure Sensitive Tape, Masking Tape, 1/4-Inch to 1 Inch Wide	A-A-883, TYPE 1, 1/4IN., 1/2IN., 3/4IN., 1IN., AND 2IN.	58536
Pressure Sensitive Tape	250-1IN	
Pressure Sensitive Tape	Y427	04963
Pressure Sensitive Tape, Vinyl Plastic	470	76381
Pressure Sensitive Tape, 1 Inch Wide	No. 855-1.000IN	76381

Table 2. Consumable Materials for Repairs (Continued)

Nomenclature	Specification No. or Manufacturers No.	CAGE or Procurement Source
Pressure Sensitive Tape, Anti Chaf Tape	8544-6.000, BLACK	04963
Primer	MIL-P-85582 TY1CL1	80244
Primer, Coating	TT-P-1757COMPLCOLORT	81348
Primer, Sealing Compound	MIL-S-22473 GRADE N and T FORM R	81349
Primer, Sealing Compound	PR-182	0NYS9
Primer, Adhesive	BR-127	07542
Primer, Adhesive	PR-142	83574
Primer Adhesive	1200 RTV PRIME COAT - CLEAR	71984
Primer Adhesive Qt	PR-1826CLB-2, CLC-1	83574
Primer, Mold Line Surfaces	MIL-P-23377, TY2, CL1	81349
Protective Plug	NAS818	80205
Pulverized Pigment, Filler Thickener	CAB-O-SIL M-5	80798
Quick-Set Laminating System, Quickset Plastic, Hardener	RP1135A/B	02684
Radius Washer	NAS1401-4DS	80205
Release Agent	Camie A1000	31868
Release Agent	S00311	09800
Respirator With Cartridge	GGG-M-125/6	81349
Rotating Fiber Brush, Flap Brush, Nonwoven, Non Metallic	61-7715-5408-8	27293
Rotating Fiber Brush, Flap Brush, Nonwoven, Non Metallic	61-7715-5507-7L	27293
Rubber Compound	RTV90	01139

Table 2. Consumable Materials for Repairs (Continued)

Nomenclature	Specification No. or Manufacturers No.	CAGE or Procurement Source
Rubber or Plastic Tubing, 1/2-Inch Diameter	COMMERCIAL	81349
Rubber Primer	SS4004	01139
Rubber Sheet, Chloroprene	MIL-R-6855, CLASS 2, TYPE EA, GRADE 40	81349
Rubber Pad, 4 X 4 X 1/8	COMMERCIAL	81349
Rubber Plate, Silicone Rubber, 0.125 X 2.500 X 5.000	COMMERCIAL	81349
Rubber Strip, Nonmetallic Special, Chloroethene Rubber Strip	11M1016-1	76301
Sand Blast Paper	PROTEX 20X	06929
Sanding Disc, 240 Grit	COMMERCIAL	81349
Scouring Powder, Non Chlorine Bleach	AA47, P-S-311	58536
Scouring Powder	A-A-14	58536
Scraper, Welding Rod	COMMERCIAL	81348
Seal, Rubber - Nose Radome	74A311026-2001	76301
Sealant Scraper, Fabricate	L-P-513-T4-PBG-0.500	81348
Sealant Scraper, Fabricate	PHENOLIC, MICARTA, FORMICA	81348
Sealing Compound	G651A, Q4-2805	01139 or 71984
Sealing Compound, 8 Oz Tube	94-031	71984
Sealing Compound	PR-1725 B-1/2	83574
Sealing Compound, Firewall Sealant	MIL-S-38249 TYPE 1 and 2	81349
Sealing Compound	RTV-88	01139

Table 2. Consumable Materials for Repairs (Continued)

Nomenclature	Specification No. or Manufacturers No.	CAGE or Procurement Source
Sealing Compound, High Temperature, Sealant	MIL-S-83430 or PR-1750 CLA-1/2 A-2 A-4 B-1/4 B-1/2 B-2 B-4 B-6	81349 or 83574 81349 or 83574 81349 or 83574 81349 or 83574 81349 or 83574 81349 or 83574 81349 or 83574 81349 or 83574
Sealing Compound, Non Curing, Extruded Tape	MIL-S-11030 TYPE 1 and 3	81349
Sealing Compound, Temperature Resistant	MIL-S-8802 TY2 or PR-1422 CLASS A-1/2 A-1 A-2 A-4 B-1/2 B-1 B-2 B-4	81349 or 83574 81349 or 83574 81349 or 83574 81349 or 83574 81349 or 83574 81349 or 83574 81349 or 83574 81349 or 83574
Sealing and Coating Compound, Corrosion Inhibitive	MIL-S-81733 TYPE I-1/2 I-2 II-1/2 II-2 II-4 IV-12 IV-24	81349 81349 81349 81349 81349 81349 81349 81349
Sealing and Coating Compound, Corrosion Inhibitive, Aluminum Pigmented	PR-1436 CLASS I-1/2 I-2 II-1/2 II-2 II-4	83574 83574 83574 83574 83574 83574
Sealing Compound Kit	MIL-S-29574(AS) PR-1826 CLC-1	83574
Sealing Compound Kit	MIL-S-29574(AS) PR-1826 CLB-2	83574
Sealing Compound, Retaining Compound	MIL-R-46082 TY1 and TY2	81349

Table 2. Consumable Materials for Repairs (Continued)

Nomenclature	Specification No. or Manufacturers No.	CAGE or Procurement Source
Sealing Gun Nozzles, Caulking Nozzle	420 (220544) 430 (220548) 220 550 440 (220550) 8643 (220586)	92108 92108 92108 92108 92108 92108
Shim Stock, 0.048 Thick	MIL-S-22499, CLASS 2, TYPE 1	81349
Silicone Rubber Pad	COMMERCIAL	81349
Silicone Rubber Strip	ZZR765CL3AGR50-0-020	81348
Skin	74R092027-2001	76301
Sodium Dichromate	O-S-595	81348
Sodium Hydroxide	A-A-895	58536
Solder, Wire, 157° Melting Point	CERROBEND1-8IN1LB	78764
Soldering Flux	MIL-F-14256 TYPE RMA	81349
Solvent, Wipe	DS-108F	30256
Spacer	NAS43DD3-14	81349
Spacer	74A330713 or 74A330755	76301
Sponge Stick Moistener	AA137	58536
Spring Pin	MS16562-1	96906
Spring Pin, Oversized	MS16562-27	96906
Spun Glass Roving, Fiberglas	475-BA-450, YIELD, TYPE 30	12760
Spun Glass Roving, Fiberglas	410-AA-450, TYPE 30	45255
Steel Angle, 4.00 × 0.125 Inch, Length As Required	COMMERCIAL	81348
Steel Music Wire, Non electric Wire, Wire	QQ-W-470, 0.040 INCH	81348
Stepan Foam	P-506	87570
Sulfuric Acid	O-S-809 TYPE 1 CLASS 1	81348

Table 2. Consumable Materials for Repairs (Continued)

Nomenclature	Specification No. or Manufacturers No.	CAGE or Procurement Source
Support	74A331366 74A331367 74A331368	76301 76301 76301
Tabacco Cleaner, Pipe Cleaner	840507/COMMERCIAL	19203 or 80244
Talcum Powder, Adhesive Inhibitor, Mica Powder, Soapstone	A-A-42	58536
Tape, Insulation	MYLAR-TYPE A 0.00142TH	18873
Tape, Scotch Mount VHB, Double Coated	Y-4949	52152
Tape, Scotch, Polyurethane Protective Tape 0.12 Thick X3.00 Wide	8650-14	76381
Teflon Cloth, Porous Release Fabric	TEMP-R-GLAS 3TLL	71643
Teflon Cloth, Non Porous Release Fabric	TEMP-R-GLAS 6TB	71643
Teflon Strip, 0.015 Inch Thick, Etched on One side, Film	MIL-I-18746	81343
Temperature Indicating Material, 275°F Rating	TEMPILSTIK 275 DEG F	82682 (94858)
Temperature Resistant Sealing Compound	MIL-S-8802	81349
Tempra Color, Water Soluble Paint	COMMERCIAL	81349
TFE Plastic Sheet Polytetrafluoroethylene, 0.125 and 0.188	AMS 3667-0-125X36X48 or AMS 3667-0-188X36X48	81343
Thermal Blanket, Insulation Blanket	MMS-582	76301
Thermal Blanket, Turco	74A800664	76301
Thermal Foam, 0.250, Thermal Insulation	MMS-553, TYPE 1, CLASS 2	76301

Table 2. Consumable Materials for Repairs (Continued)

Nomenclature	Specification No. or Manufacturers No.	CAGE or Procurement Source
Thermal Insulation, Same as MMS-553, Type 1	TRYMER 9501	96717
Thermal Insulation, Same as MMS-553, Type 1	THERMAREST 5152	96717
Thermofit Sleeve, 1/16 Inch Dia, White	M23053/5-102-9	81349
Thermofit Sleeve, 1/8 Inch Dia, Black	M23053/5-104-0	81349
Thermofit Sleeve, 3/16 Inch Dia, White	M23053/5-105-9	81349
Thermofit Sleeve, 3/16 Inch Dia, Black	M23053/5-105-0	81349
Titanium Foil Patches	18AC-SRM-Ti-2001 through-2049	Fabricate: (A1-F18AC-SRM-250, WP006 00)
Thread, Fiberglass	B-4, B-6, E-12, E-18	45255
Thread Lock, Locktite, Adhesive Thread Locker No 242, 50 ML Tube	24231 (22221)	05972
Titanium Foil Sheet, 0.012 Thick	Ti-15V-3CR, 3SN-3AL, AMS-4914,	76301
Titanium Foil Sheet, Annealed	6AL-4V, 0.016 INCH	76301
Toluene, Technical	TT-T-548	81348
Tongue Depressor, Wooden Spatula	GG-D-226 TYPE 1	81348
Toothpicks, Round	COMMERCIAL	81348
Toothbrush	H-T-560 TYPE 1 STYLE B	81348
Tool Steel	A6, 1.125 INCH DIA	81348
Toxicological Gloves, Neoprene Gloves	MIL-G-12223, TYPE 2, SMALL, MEDIUM, and LARGE	81349
Transducer, Motional Pickup, Strain Gage	DTD2684-1	07571

Table 2. Consumable Materials for Repairs (Continued)

Nomenclature	Specification No. or Manufacturers No.	CAGE or Procurement Source
Transducer, Motional Pickup, Strain Gage	DTD2684-2	07571
Transducer, Motional Pickup, Strain Gage	DTD2684-3	07571
Transducer, Motional Pickup, Strain Gage	DTD2684-4	07571
Transmission Seal, Lower, Metal Sheet	74A190616, MIL-T-9046, TYPE 3, COMP-112	76301
Transmission Seal, Upper, Metal Sheet	74A190618, QQ-A-250/13, COND T6-0-071	76301
Tubing, Nonmetal 0.1250ODX0.95ID	HC2-54025, TYPE LM NYLA- FLOW	83616
Untreated Kraft Paper	A-A-203	58536
Utility Apron, General Purpose Apron	MIL-A-41829	81349
Varnish Brush, Flat, 1/4-Inch to 3 Inches Wide	H-B-695 TYPE 1 GRADE A SIZE 1 or 2	81348
Velcro Fastener Tape, Hook	MIL-F-21840, TYPE 2, CLASS 1H	81349
Velcro Fastener Tape, Pile	MIL-F-21840, CLASS 1P	81349
Velcro Fastener Loop, Bulk Mate- rial, 1.00, Fastener Tape	HI-MEG NO. 1000	81349
Weather Seal, Nonmetallic	11M1025-1 11M966-1	76301 76301
Wire, 0.050 or Greater	COMMERCIAL	81348
Wire Braid, Tublar, 0.125 X 0.020	QQ-B-375-36-0078, 8660 or 8654	16428
Wire Cable, 1.0 Inch	COMMERCIAL	81348
Wire Fabric, 304 CRES 0.125 Grid, 0.020 Screen	RR-W-360, CLASS 1, TYPE 1	81348
Wire Mesh Knit	0045R26X1	59950

Table 2. Consumable Materials for Repairs (Continued)

Nomenclature	Specification No. or Manufacturers No.	CAGE or Procurement Source
Wire Rope, 7 × 7, 0.250 Inch	COMMERCIAL	81348
Wire Screen, 0.011 Inch Dia., Knit Weave, Single Strand, 302 or 304 CRES, 0.192 Needles, 48 Density	RR-W-360, CLASS 1, TYPE 1	15835 or 12881
Wire Tafa, Tin Zinc	QQ-T-371	81348
Wood Planks 4 ×12, as Required	COMMERCIAL	81348
X-Acto Knife	COMMERCIAL	99941 / 81348

Table 3. Consumable Materials for Nondestructive Inspection

Nomenclature	Specification No. or Manufacturers No.	CAGE or Procurement Source
Abrasive Mat, Non Woven, Non Metallic, Fine, 0.25 Thick	MILA9962TY1CL1GRB-X9X11	81349
Acid Swab Brush	H-B-643, TYPE2, CLASS 1, SIZE 1	81348
Acrylic Plastic, Sheet, Lucite Ma- terial, 0.090 Inch, (0.100)	MIL-P-8184	81349
Aircraft Cleaning Compound	MIL-C-85570	81348
Aircraft Grease	MIL-G-81322	81349
Aircraft Marking Pencil	MIL-P-83953-2, TYPE 1, CLASS A or B, BLACK or RED	81349
Aluminum Oxide Abrasive Cloth	AA1048TY1CL1GRIT240, 300, 400 X9X11	58536
Barrier Material	MIL-B-121, TY1GRACL1	81349
Cheesecloth	CCC-C-440 TYPE 1 CLASS 1	81348
Chemical Gloves, Rubber Gloves	ZZ-G-381, TYPE 1, STYLE 1, SMALL, MEDIUM, and LARGE	81348
Cleaning Cloth	MIL-C-87962, TYPE 1	81349
Corrosion Preventive	MIL-C-85054 TY1	80244

Table 3. Consumable Materials for Nondestructive Inspection (Continued)

Nomenclature	Specification No. or Manufacturers No.	CAGE or Procurement Source
Couplant	ULTRAGEL II	57869
Cutting Fluid, Coolant for Magnetic Particle Bath	ISOPAR M	29700
Disposable Applicator, Cotton Swab, (Q Tips)	6-143	89875
Distilled Water	DISTILLEDWATER COMMERCIAL	81348
Dry Cleaning Solvent	P-D-680, TYPE 2	81348
Fastener	ST3M760C5-12, HLT53YC-()-()	81348
Fastener	ST3M760C5-15, HLT53YC-()-()	81348
Fastener	ST3M760C5-17, HLT53YC-()-()	81348
Fastener	ST3M760C5-(), HLT53YC-()-()	81348
Fluorescent Magnetic Inspection Powder	AMS3044	37676 or 81343
Magnetic Inspection Powder, Red	AMS3042	37676 or 81343
Methyl Isobutyl Ketone	D 1153	81348
Paint Remover, Epoxy System	MIL-R-81294 TY1	81349 or 80244
Penetrant Emulsifier	MIL-I-25135 TY1	81349
Petrolatum, Couplant	NDC00182-0182-45	63488
Pressure Sensitive Tape, Masking Tape, 1/4 thru 1 Inch Wide	A-A-883, TYPE 1, 1/4IN., 1/2IN., 1IN.	81348
Radiographic Film, X-ray Film, 14 X 17	INDUSTREXAA FILM-CODEAA2 14X17	19139
Radiographic Film, X-ray Film, 5 X 7	INDUSTREX AA FILM CODE AA-2	19139
Radiographic Film, X-ray Film, 14 X 17	INDUSTREX M FILM CODE M-2	19139

Table 3. Consumable Materials for Nondestructive Inspection (Continued)

Nomenclature	Specification No. or Manufacturers No.	CAGE or Procurement Source
Radiographic Film, X-Ray Film, 14X17	INDUSTREXAAFILMCODE 14X17	19139
Radiographic Film, X-ray Film, 5 X 7	INDUSTREXMFILMCODEM2 5X7	19139
Radiographic Film, X-ray Film	179-6531 INDUSTREXM/AA READY PAK DUO, 14 X 17	19139
Radiographic Film, X-ray Film	145-8926 KODAK, M2, READY PACK	19139
Radiographic Film, X-ray Film	145-9205 AA-2, READY PACK 14 X 17	19139
Radiographic Film, X-ray Film	807699 DAYPACK, DUPONT CRONEX 14 X 17	OPMS6
Radiographic Film, X-ray Film	807850 DAYPACK, DUPONT CRONEX 14 X 17	OPMS6
Sealant Scraper, Plastic Sheet	L-P-513-T4-PBG-0.500	81348
Sealing Compound	MIL-S-83430 CLB-2	81349 or 83574
Teflon Block, 2.25X2.25X1.00	MIL-R-8794	81349
Thinner, Aliphatic Naptha	MIL-T-81772-TY1	81349
Tube Type Marker	673T	05360 or 81348
Varnish Brush	H-B-695 TYPE1 GRADEA SIZE 1 1/2 OR SIZE 2	81349
Washing Bottle	MS36070	81349

Table 4. Kits Containing Consumable Material for Repair

Nomenclature	Specification No. or Manufacturers No.	CAGE or Procurement Source
Adhesive Repair, Staged Packaged Kit; FM300	74K000004	76301
Aluminum Alloy Honeycomb Plug, Repair Kit	135001-1001, -1003, -1005, -1007, -1009, -1011 (74K000005) -1001 =9X9X2 -1003 =9X9X4 -1005 =9X9X6 -1007 =12X12X2 -1009 =12X12X4 -1011 =12X12X6	91145 (76301)
Bolted Patch, Repair Kit	74K000006	76301
Graphite Epoxy, Pre-cured, Repair Kit	74K000002	76301
Maintenance Kit	MIL-M-58091	32834
Shim Kit	874450-801	81348
Structural Repair Kit, Sheet Elastomeric	WF2406CL3SHEETC	83574
Structure Repair Kit, Elastomeric, Standard Material,	WF2406CL3XX004C	83574
Structural Repair Kit, Elastomeric Repair Material, 4 Oz. Kit	WF2405CL3XX004C	83574
Structural Repair Kit, Rain Erosion Seal, 4 Oz. Kit	WF1664XXXXXX004C	83574
Titanium Patch, Repair Kit	74K000003	76301

Table 5. Gang Channels, Esna

2 Equivalent Part Number	1 McDonnell Standard Number
G10851J3-9	3M448N3M9-64
G10851J3-10	3M448N3M10-57
G10851J3-11	3M448N3M11-52
G10851J4-8	3M448N4M8-72
G10851J4-10	3M448N4M10-57
G10851J4-11	3M448N4M11-52
G10851J4-12	3M448N4M12-48
G10851-3-9	3M448C3M9-64
G10851-3-10	3M448C3M10-57

Table 5. Gang Channels, Esna (Continued)

2 ➤ Equivalent Part Number	1 ➤ McDonnell Standard Number
G12093-2-3-12	ST3M723C2M12-13
G12093J2-3-8	ST 3M723N2M8-72
G12093J2-3-9	ST3M723N2M9-64
G12093J2-3-10	ST3M723N2M10-57
G12093J2-4-8	ST3M723N2M8-72
G12093J2-4-9	ST3M723N2M9-64
G12093J2-4-10	ST3M723N2M10-57
G12093J4-3-9	ST3M723N4M9-64
G12093J4-3-10	ST3M723N4M10-57
G12094J3-7	ST3M723N1M7-82
G12094J3-8	ST3M723N1M8-72
G12094J3-9	ST3M723N1M9-64
G12094J3-10	ST3M723N1M10-57
G12094J3-12	ST3M723N1M12-3
G12094J4-8	ST3M724N1M8-72
G12094J4-11	ST3M724N1M11-52
G12094J4-12	ST3M724N1M12-3
G50344-5-1-()	ST3M777N1-12L3
G14421-1-4-9-64	ST3M544N9A64-1
G14421-1-4-10-57	ST3M544N10A57-1
G14421-1-4-11-52	ST3M544N11A52-1
G14421-1-4-12-48	ST3M544N12A48-1
G14421-2-3-9-64	ST3M543N9A64-1
G14421-2-3-10-57	ST3M543N10A57-2
G14421-2-4-11-52	ST3M544N11A52-2
G14421-2-4-12-48	ST3M544N12A48-2
G14421-2-4-14-41	ST3M544N14A41-2
G14421-4-4-8-72	ST3M544N8A72-4
G14421-4-4-9-64	ST3M544N9A64-4
G14421-4-4-10-57	ST3M544N10A57-4
G14421-4-4-11-52	ST3M544N11A52-4
G14421-4-4-12-2	ST3M544N12A2-4
G14421-4-4F-12-2	ST3M544F12A2-4
G14421-4-4-12-48	ST3M544N12A48-4
G14421-4-4-13-2	ST3M544N13A2-4
G14421-4-4-13-44	ST3M544N13A44-4
G14421-4-4-14-41	ST3M544N14A41-4
G14421-4-4-16-36	ST3M544N16A36-4
G14421-4-4-18-32	ST3M544N18A32-4
G14421-6-4-8-72	ST3M544N8A72-6
G14421-6-4-9-64	ST3M544N9A64-6

Table 5. Gang Channels, Esna (Continued)

2 ➤ Equivalent Part Number	1 ➤ McDonnell Standard Number
G14421-6-4-9-66	ST3M544N9A66-6
G14421-6-4-10-57	ST3M544N10A57-6
G14421-6-4-11-52	ST3M544N11A52-6
G14421-6-4-12-48	ST3M544N12A48-6
G14421-6-4-13-44	ST3M544N13A44-6
G14421-6-4-16-36	ST3M544N16A36-6
G14421-6-4-18-32	ST3M544N18A32-6
G18421JL1-3-11	ST3M463N11A52-1
G18421JL1-3-12	ST3M463N12A48-1
G18421JL1-3-13	ST3M463N13A44-1
G18421JL1-4-7	ST3M464N7A82-1
G18421JL1-4-8	ST3M464N8A72-1
G18421L()-4-()	ST3M464C8A72-1
G18421JL1-4-9	ST3M464N9A64-1
G18421JL1-4-10	ST3M464N10A57-1
G18421JL1-4-12	ST3M464N12A48-1
G18421JL1-5-9	ST3M465N9A64-1
G18421JL1-5-10	ST3M465N10A57-1
G18421JL1-5-11	ST3M465N11A52-1
G18421JL1-5-12	ST3M465N12A48-1
G18421JL1-5-15	ST3M456N15A()-()
G18421JL2-3-14	ST3M463N14A41-2
G18421JL2-4-7	ST3M464N7A82-2
G18421JL2-4-8	ST3M464N8A72-2
G18421L()-4-()	ST3M464C8A72-2
G18421JL2-4-9	ST3M464N9A64-2
G18421JL2-4-10	ST3M464N10A57-2
G18421JL2-4-11	ST3M464N11A52-2
G18421JL2-4-12	ST3M464N12A48-2
G18421JL2-4-14	ST3M464N14A41-2
G18421JL2-5-10	ST3M465N10A57-2
G18421JL2-5-11	ST3M465N12A52-2
G18421JL2-5-12	ST3M465N12A48-2
G18421JL2-5-13	ST3M465N13A44-2
G18421JL3-4-7	ST3M464N7A82-3
G18421JL3-4-8	ST3M464N8A72-3
G18421JL3-4-9	ST3M464N9A64-3
G18421JL3-4-10	ST3M464N10A57-3
G18421JL3-4-11	ST3M464N11A51-3
G18421JL3-4-12	ST3M464N12A48-3
G18421JL3-4-14	ST3M464N14A41-3
G18421JL3-5-10	ST3M465N10A57-3
G18421JL3-5-12	ST3M465N12A48-3
G18421JL3-5-13	ST3M465N13A44-3
G18421JL3-5-14	ST3M465N14A41-3
G18421JL3-5-16	ST3M465N16A36-3
G18421JL4-4-8	ST3M465N8A72-4
G18421JL4-4-9	ST3M464N9A64-4
G18421JL4-4-10	ST3M464N10A57-4
G18421JL4-4-11	ST3M464N11A52-4

Table 5. Gang Channels, Esna (Continued)

2 Equivalent Part Number	1 McDonnell Standard Number
G18421JL4-4-13	ST3M464N13A44-4
G18421JL4-5-9	ST3M465N9A64-4
G18421JL4-5-10	ST3M465N10A57-4
G18421JL4-5-11	ST3M465N11A52-4
G18421JL4-5-14	ST3M465N14A41-4
G18421JL4-5-8	ST3M465N8A72-4
G18421JL5-4-8	ST3M464N8A72-5
G18421JL5-4-11	ST3M464N11A52-5
G18421JL5-4-12	ST3M464N12A48-5
G18421JL5-4-10	ST3M464N10A57-5
G18421JL5-4-11	ST3M464N11A52-5
G18421JL6-4-7	ST3M464N7A86-6
G18421L()-4-()	ST3M464C7A86-6
G18421JL6-4-8	ST3M464N8A72-6
G18421JL6-4-9	ST3M464N9A64-6
G18421JL6-4-10	ST3M464N10A57-6
G18421JL6-4-11	ST3M464N11A52-6
G18421L()-4-()	ST3M464C11A52-6
G18421JL6-4-12	ST3M464N12A48-6
G18421JL6-4-13	ST3M464N13A44-6
G18421JL6-5-9	ST3M465N9A64-6
G18421JL6-5-10	ST3M465N10A57-6
G18421JL6-5-11	3M465N11A52-6
G18421JL6-5-13	ST3M465N13A44-6
G18421JL9-4-9	ST3M464N9A4-9
G18421L1-4-8	ST3M464C8A2F1
G18421L2-4-8	ST3M465C8A43L2
G18421L4-4-8	ST3M464C8A-4-8
G18421L4-4-9	ST3M465C8A-4-8
G18421L4-4-18	ST3M464C8A72-4
G18421L4-4-11	ST3M464C11A52-4
G18421L4-4-12	ST3M464C12A48-4
G18421L6-4-7	ST3M464C7A3-6
G18421L6-4-8	ST3M464C8A-4-8
G18421L6-4-9	ST3M464C9A-4-9
G18421L6-4-11	ST3M464C11A2F6
G18421L6-4-13	ST3M464C13A44-6
G18421L6-4-15	ST3M464C15A38-6
G18421PL2-5-15	—
LEGEND 1 McDonnell Aircraft Company (76301). 2 Esna Division of Amerace Corporation (72962).	

Table 6. Gang Channels, Kaynar

2 Equivalent Part Number	1 McDonnell Standard Number
G49461-3-7	3M448N3M7-82

Table 6. Gang Channels, Kaynar (Continued)

2 ➡ Equivalent Part Number	1 ➡ McDonnell Standard Number
G49461-3-8	3M448N3M8-72
G49461-3-9	3M448N3M9-64
G49461-3-10	3M448N3M10-57
G49461-3-11	3M448N3M11-52
G49461-3-12	3M448N3M12-48
G40344-3-1-11	ST3M723N1M11-52
G50344-3-1-7	ST3M723N1M7-82
G50344-3-1-8	ST3M723N1M8-72
G50344-3-1-9	ST3M723N1M9-64
G50344-3-1-10	ST3M723N1M10-57
G50344-3-1-11	ST3M723N1M11-52
G50344-3-1-12	ST3M723N1M12-48
G50344-3-2-8	ST3M723N2M8-72
G50344-3-2-10	ST3M723N2M10-57
G50344-3-8-4	ST3M723N8M4
G50344-3-9-3	ST3M723N9M3
G50344-3-9-4	ST3M723N9M4
G50344-3-2-11	ST3M723N2M11-52
G50344-3-11-2	ST3M723N11M2
G50344-4-1-14	ST3M723N1M14-41
G50344-5-1-10	ST3M775N1-10-57
G50345-3-1-12	ST3M723C1M12-48
G50345-3-1-14	ST3M723C1M14-41
G50345-3-2-11	ST3M723C2M11-52
G50345-3-2-12	ST3M723C2M12-48
G50345-3-2-14	ST3M723C2M14-41
G50345-3-2-16	ST3M723C2M16-36
G51061-4-4	ST3M862N1M4-4
G51061-4-8	ST3M862N1M8-72
G51061-4-12	ST3M862N1M12-48
G51061-4-14	ST3M862N1M14-41
G51061-4-9	ST3M862N1M9-64
G51061-4-10	ST3M862N1M10-57
G51061-4-11	ST3M862N1M11-52
LEGEND 1 ➡ McDonnell Aircraft Company (76301). 2 ➡ Kaynar Manufacturing Company Incorporated (75237).	

Table 7. Plate Nuts

2 ➡ Equivalent Part Number	1 ➡ McDonnell Standard Number
3 ➡ F12092-1-4	ST3M721C4M1
3 ➡ F12092-2-3	ST3M721C3M2
3 ➡ F12092-4-4	ST3M721C4M4
F12198-4	ST3M725C4M4
F1972-4-4	3M144A4-4
F2000-3	—
—	MS21062L4

Table 7. Plate Nuts (Continued)

2 ➤ Equivalent Part Number	1 ➤ McDonnell Standard Number
F29337-4-2	3M63A4-2
F29337-4-4	3M63A4-4
F29337-4-6	3M63A4-6
MF52099-()	3M1050A3
F52009-4	3M1030-4
F29339-01-3	ST3M470C3M
F29339-01-5	ST3M470C5M
F39668-3	ST3M5413A1
F39668-4	ST3M5414A1
F39668-5	ST3M5415A1
F39668-6	ST3M5416A1
F39669N-4-1	ST3M542-4A1
F39669N-4-2	ST3M542-4A2
F39669N-4-4	ST3M542-4A4
F39669N-4-6	ST3M542-4A6
F49069N3-2	ST3M5413A2
F39669N-4-1	ST3M542-4A1
F39879-4-2	ST3M5424A-2
F39879-4-6	ST3M542A6
F39879N-4-4	ST3M5424D4
F39879N-4-6	ST3M5424D6
F49069N-3-4	ST3M5413A4
F49069N3-6	ST3M5413A6
F49069N-4-1	ST3M5414A1
F49069N-4-2	ST3M5414A2
F49069N-4-4	ST3M5414A4
F49069N-4-6	ST3M5414A6
F49249E3-1	ST3M443-3A1
F49249E3-2	ST3M443-4A2
F49249E3-3	ST3M443-4A3
F49249E3-4	ST3M443-3A4
F49249E3-5	ST3M443-3A5
F49249E3-6	ST3M443-3A6
F49249E4-1	ST3M443-4A1
F49249E4-2	ST3M443-4A2
F49249E4-3	ST3M443-4A3
F49249E4-4	ST3M443-4A4
F49249E4-5	ST3M443-4A5
F49249E4-6	ST3M443-4A6
F49249E5-1	ST3M443-5A1
F49249E5-2	ST3M443-5A2
F49249E5-3	ST3M443-5A3
F49249E5-4	ST3M443-5A4
F49249E5-5	ST3M443-5A5
F49249E5-6	ST3M443-5A6
F49249E6-1	ST3M443-6A1
F49249E6-2	ST3M443-6A2
F49249E7-1	ST3M443-7A1
F49249F4-1	ST3M443-4A1
F49251E3-1	ST3M442-3A1

Table 7. Plate Nuts (Continued)

2 ➤ Equivalent Part Number	1 ➤ McDonnell Standard Number
F49251E3-2	ST3M442-3A2
F49251E3-3	ST3M442-3A3
F49251E3-4	ST3M442-3A4
F49251E3-6	ST3M442-3A6
F49251E4-1	ST3M442-4A1
F49251E4-2	ST3M442-4A2
F49251E4-3	ST3M442-4A3
F49251E4-4	ST3M442-4A4
F49251E4-6	ST3M442-4A6
F49251E5-1	ST3M442-5A1
F49251E5-2	ST3M442-5A2
F49251E5-3	ST3M442-5A3
F49251E5-4	ST3M442-5A4
F49251E5-6	ST3M442-5A6
F5000-4	MS21059L4
F5000-5	MS21059L5
F5000-08	MS21059L08
F5001-3	MS21060L3
F5001-4	MS21060L4
F5001-4	MS21060DL4
F5031-3	MS21060-3
—	MS21062-3
F50339-3-1	ST3M719C3M1
F50339-3-2	ST3M719C3M2
F50339-3-4	ST3M719C3M4
F50339-4-1	ST3M719C4M1
F50339-4-2	ST3M719C4M2
F50339-4-4	ST3M719C4M4
F50339-4-6	ST3M719C4M6
F50339-4-12	ST3M719C4M12
F50339-4-14	ST3M719C4M14
F50339-5-2	ST3M719C5M2
F50340-3-1	ST3M720C3M1
F50340-3-2	ST3M720C3M2
F50340-3-4	ST3M720C3M4
F50340-4-1	ST3M720C4M1
F50340-4-2	ST3M720C4M2
F50340-4-4	ST3M720C4M4
F50340-4-6	ST3M720C4M6
F50340-4-12	ST3M720C4M12
F50340-5-1	ST3M720C5M1
F50343-4-10	ST3M722C4M4
F50343-4-13	ST3M722C4M9
F50403-3-1	ST3M721C3M1
F50403-3-2	ST3M721C3M2
F50403-3-4	ST3M721C3M4
F50403-4	ST3M721C3M4
F50403-4-1	ST3M721C4M1
F50403-4-2	ST3M721C4M2
F50403-4-4	ST3M721C4M4

Table 7. Plate Nuts (Continued)

2 Equivalent Part Number	1 McDonnell Standard Number
F50403-4-6	ST3M721C4M6
F50403-5-1	ST3M721C5M1
F50403-5-2	ST3M721C5M2
F50403-5-4	ST3M721C5M4
F50403-5-6	ST3M721C5M6
F50403-6-1	ST3M721C6M1
F50403-6-2	ST3M721C6M2
F50405-3	ST3M725C3M
F50405-4	ST3M725C4M
F50406-3	ST3M726C3M
F50406-4	ST3M726C4M
F51827-4-16	—
K1000-3	MS21047L3
—	MS21061L4
-	MS21065
—	MS21070L3
—	MS210073L4
—	MS20025L3
K3000-4	MS21055L4
—	MS21076-3
ME1000-4	—
MF1000-4	MS21075L4
MF1001-4	MS21076L4
MF1001-5	MS21076L5
NAS1870-4-2	—
NAS1870-4-6	—
NAS1870CL3-3	—
4 RMF19421-2-4	ST3M541-2A4
4 RMF19421-4-4	ST3M541-4A4
4 RMF19421-6-4	ST3M541-6A4
VA2144-23	—
LEGEND 1 McDonnell Aircraft Company (76301). 2 Kaynar Manufacturing Company Incorporated (75237), except as noted. 3 Esna Division of Amerace Corporation (72962). 4 Elastic Stop Nut Corporation (72962).	

Table 8. Receptacles

2 Equivalent Part Number	1 McDonnell Standard Number
1950-5-6-2	3M304-5-6-2
1950-5-7-1	3M304-5-7-1
1950-5-7-2	3M304-5-7-2
1950-5-8-0	3M304-5-8-0
1950-5-8-1	3M304-5-8-1
1950-5-8-2	3M304-5-8-2
1950-6-3-4	3M304-6-3-4

Table 8. Receptacles (Continued)

2 ➤ Equivalent Part Number	1 ➤ McDonnell Standard Number
1950-6-3-6	3M304-6-3-6
1950-6-6-2	3M304-6-6-2
1950-6-4-6	3M304-6-4-6
1950-6-4-7	3M304-6-4-7
1950-6-6-3	3M304-6-6-3
1950-6-6-4	3M304-6-6-4
1950-6-6-5	3M304-6-6-5
1950-6-7-2	3M304-6-7-2
1950-6-7-3	3M304-6-7-3
1950-6-7-4	3M304-6-7-4
1950-6-8-0	3M304-6-8-0
1950-6-8-1	3M304-6-8-1
1950-6-8-2	3M304-6-8-2
1950-6-8-3	3M304-6-8-3
1950-6-9-0	3M304-6-9-0
1950-6-9-1	3M304-6-9-1
1950-6-9-2	3M304-6-9-2
1950-6-9-3	3M304-6-9-3
1950-6-9-4	3M304-6-9-4
1950-6-10-0	3M304-6-10-0
1950-6-10-01	3M304-6-10-01
1950-6-10-1	3M304-6-10-1
1950-6-10-2	3M304-6-10-2
1950-6-10-4	3M304-6-10-4
1950-6-11-0	3M304-6-11-0
1950-6-12-0	3M304-6-12-0
1950-10-11-0	3M304-6-11-0
195012-5-2-6	3M304C5-2-6
195012-5-3-5	3M304C5-3-5
195012-5-4-4	3M304C5-4-4
195012-5-4-5	3M304C5-4-5
195012-5-5-3	3M304C5-5-3
195012-5-6-2	3M304C5-6-2
195012-5-6-3	3M304C5-6-3
195012-5-7-1	3M304C5-7-1
195012-5-8-0	3M304C5-8-0
195012-6-7-3	3M304C6-7-3
195012-6-9-03	3M304C6-9-03
195012-6-9-3	3M304C6-9-3
195012-6-10-1	3M304C6-10-1
195012-6-10-2	3M304C6-10-2
195012-6-10-03	3M304C6-10-03
195012-6-10-3	3M304C6-10-3
195012-6-11-1	3M304C6-11-1
195012-6-11-2	3M304C6-11-2
195012-6-12-0	3M304C6-12-0
195012-6-12-1	3M304C6-12-1
1955-5-9-0	3M897-5-9-0
1955-6-3-5	3M897-6-3-5
1955-6-6-5	3M897-6-6-5

Table 8. Receptacles (Continued)

2 Equivalent Part Number	1 McDonnell Standard Number
1955-6-9-0	3M897-6-9-0
1955-6-11-0	3M897-6-11-0
1960-6-6-3	3M310-6-6-3
1960-6-7-2	3M310-6-7-2
1960-6-8-2	3M310-6-8-2
1960-6-9-1	3M310-6-9-1
1960-6-9-2	3M310-6-9-2
196012-5-1-9	3M310-5-1-9
196012-5-2-6	3M310-5-2-6
1960-6-12-0	3M310-6-12-0
196012-6-9-01	3M310C6-9-01
106-12-6-10-1	3M310C6-10-1
196012-6-10-2	3M310C6-10-2
3M975-4C1-119	52171A-4C1-119
521714C2-060	ST3M590-4C2-060
52171A-4C1-119	—
LEGEND 1 McDonnell Aircraft Company (76301). 2 SPS Western (80539).	

Table 9. Shims and Washers

McDonnell Standard Number
AN960C416
AN960C8
AN960C4L
AN960C10
AN960C10L
AN960C516
AN960C516L
AN960D10L
AN960JD6L
AN960JD101
AN960JD516
AN960JD516L
AN960JD616L
AN960JD8L
AN960PD4L
AN960PD10L
AN960PD416
AN960PD516L
MIL-S-22499
NAS1169DD10L
NAS1169D8E
NAS1169D10E

Table 9. Shims and Washers (Continued)

McDonnell Standard Number
NAS1195C4F4
NAS1195C4FH
NAS1195C4H4
NAS1195D3WH
NAS1587A3C
NAS1587A4C
NAS1401-3D5
NAS1401-4D5
NAS1195D4WH
NAS1195D4WM
NAS1195D4XH
NAS1195D4XL
NAS1195D4XM
NAS1195C4XH
NAS1195D4WH
NAS1195D4WM
NAS1195D5WH
NAS1515M4L
NAS1587A4C
NAS463FD10
NAS463FD10M
NAS463FDD416

Table 9. Shims and Washers
(Continued)

McDonnell Standard Number
NAS463X516M
NAS463XDD416
NAS463XDD416H
NAS463XDD416L
NAS463XDD416M
NAS463X-D10
NAS463X-D10M
NAS463X-D10N0
NAS463XD616
NAS463XD616L
NAS463XD616M
NAS463XD716
NAS463XD716L
NAS463XD716M
NAS463XD416H
NAS463XD416L
NAS463XD416N0
NAS463XD616H
NAS463YD416
NAS463YDD416
NAS463YDD416M
NAS463YD416H
NAS463YD416M
NAS463FD516M
NAS620A5
NAS620C4L
NAS620C5L
NAS620C6L
4M27-3
4M27C5
4M119
4M119D6
4M30C10-032
4M30C416-064
4M30C516-032
4M30C516-064
4M30C516-125
4M30D516-125
4M30D616-125
4M30E416-125
4M30E516M
4M36-01070
4M36-02099
TLN1023CD3L6W
4M36-02109
4M36-02110
4M36-04042
4M38A616L

Table 9. Shims and Washers
(Continued)

McDonnell Standard Number
4M49-3DL9
4M49-3DL10
4M49-3DT8
4M49-3KL7
4M49-3KL8
4M49-3KL9
4M49-3KL10
4M49-3KM8
4M49-3KM9
4M49-4DL8
4M49-4DL10
4M49-4DM6
4M49-4DM7
4M49-4DM8
4M49-4DM9
4M49-4DM10
4M49-4DM11
4M49-4DM13
4M49-4DT8
4M49-4DT9
4M49-4DT16
4M49-4KM8
4M49-4KM11
4M49-4KM12
4M49-45KM12
4M49-5KM14
74A661247-2037
74A661247-2039
74A330710
74A360001-2083
74A360001-2085
74A350866-2003
74A350866-2005
74A350866-2007
74A350866-2009
74A350866-2011
74A350866-2013
74A350866-2015
74A350866-1001
74A350747-2001
74A350847-2023
74A350847-2021
74A350847-2009
74A350847-2011
74A350847-2017
74A350847-2019
74A350874-2003
74A350838-1001

Table 10. Longer Than Standard Jo-Bolts

Part Number	Oversize Part Number
NAS1669-3L4 Thru 25	NAS1751-3L()

Table 11. Close Tolerance Screws

Equivalent Part Number	McDonnell Standard Number
HT271A4-2 Thru 15	ST3M430V4-()
HT4025L4-21	ST3M4544L21
HT4025L4-23	ST3M4544L23
HLT4068-3-()A	3M926
HT4027-3-()	ST3M557
HT4024-L3-()	ST3M455
HT4024L4-()	—

Table 12. Jo-Bolts

Equivalent Part Number	McDonnell Standard Number
NAS1669-3L2 Thru 25	—
NAS1670-08L5	—
NAS1671-08L2 Thru 24	—
NAS1671-5L()	—
NAS1672-3L2 Thru 18	—
NAS1672-4L2 Thru 24	—
NAS1672-5L2 Thru 18	—
NAS1672-3-7	—
NAS1751-3L2 Thru 24	—
NAS1752-4L2 Thru 24	—
NAS1753-3L2 Thru 24	—
NAS1754-3L	-
PLT170-6-()	—
PLT170-5-2 Thru 8	ST3M782-08-2 Thru 8
PLT170-6-3 Thru 18	ST3M782-3-3 Thru 18
PLT1058-5-2 Thru 12	ST3M781-08-2 Thru 12
PLT1058-6-()	—
PLT1100-12-()	—
PLT1101-12-()	—
PLT1102-12-()	—
PLT1058-6-2 Thru 14	ST3M781-3-2 Thru 14
PLT1064-6-2 Thru 12	—
PLT1064-6-3	—
PLT1064-6-4	—
PLT1064-6-6	—
PLT1064-8-2 Thru 12	—
PLT270-5-2 Thru 16	ST3M455-5-2 Thru 16
PLT1081-6-4	—
PLT1081-6-6	—
PLT270-5-()	—
PLT270-6-()	—

Table 13. Olympic-Loks

Part Number
NAS1398B5A4
NAS1398B5AL
NAS1398C-4()
NAS1398C5A3
NAS1398C6A3
NAS1398C6A4
NAS1398C6A6
NAS1398C6A7
NAS1398C4A()
NAS1398C6A()
NAS1398D4A3
NAS1399D4
NAS1398D4A4
NAS1399C5
NAS1399D4A()

Table 13. Olympic-Loks (Continued)

Part Number
NAS1399D5A()
NAS1399D6A()
RV1241-3-3
RV1241-3-()
NAS1399/3-6-3
NAS1399/3-6-4
NAS1399/3-6-5
NAS1399D4
NAS1399D5A
NAS1399D6A
NAS1398C4
NAS1398C4A3
NAS1398C4A4
NAS1399C4A2
NAS1399C5A3
NAS1399C5A4

Table 14. Hi-Lok Pins

Equivalent Part Number	McDonnell Standard Number
HLT50DL-5-()	—
HLT50DL-6-()	—
HLT50DL-8-()	—
HLT51DL-5-()	—
HLT51DL-6-()	—
HLT51DL-8-()	—
HLT53YC-10-17	—
HLT153TB-10-17	—
HLT310DL-5-()	—
HLT311-5-4	ST3M758V08L-4
HLT311DL-6-3	ST3M758
HLT311DL-5-()	ST3M758
HLT311DL-8	ST3M758
HLT311TB-5-5	ST3M758
HLT311DL-6-4	ST3M758
HLT311-8-5	ST3M758
HLT312TB-8-9	—
HLT610-5-3	ST3M416V08-3
HLT610-5-5	ST3M416V08-5
HL11V6-3	ST3M415V3-3
HLT310DL-6-12	—
HLT310DL-8-X	—
HLT827TB10-14	3M1158-5-14
HL610-5-3	—
HL610-5-4	—
HL610-5-5	—
HL611-5-5	ST3M415
HL611-5-8	—

Table 14. Hi-Lok Pins (Continued)

Equivalent Part Number	McDonnell Standard Number
HL611-5-16	—
HL665-5-11	—
HL665-5-12	—
HL40-5-4	—
—	3M1138-7
A1C-L-611V5	ST3M415V08-12
HL10V6-6	—
HL612-5-7	ST3M420-()
HL612-5-6	ST3M420-()
HL11V6-15	ST3M415-()
HL11V6-17	ST3M415-()
HL146-6-3-1	—
HL744LL-6-5	—
HL744LL-6-4	—
HL744LL-6-3	—
HLT310DL-5-5	—
HLT310DL-5-4	—
HLT310DL-5-3	—
HLT312TB8-9	ST3M761()-()

Table 15. Hi-Lok Collars

Equivalent Part Number	McDonnell Standard Number
HL570-5MC	ST3M525N08ME
HL570-6MC	ST3M525N3ME
HL570-8MC	ST3M525N4ME
HLT570-8MC	—
SW1000-5M	—
TLN1002CD3-5	ST3M426C

Table 16. Solid Rivets

Equivalent Part Number	McDonnell Standard Number
MS20470AD()	—
MS20470AD3	—
MS20470AD4	—
MS20470AD5	—
MS20426AD3	—
MS20426AD3-()	—
MS20426AD4	—
MS20426AD5	—
MS20426AD6	—
MS20470DD6-()	—
MS20470T-4-()	—
MS20470T5-5 thru -9	—
MS20470T4-4 thru -7	—
MS20470T-6	—
MS20470T-5-()	—

Table 16. Solid Rivets (Continued)

Equivalent Part Number	McDonnell Standard Number
MS20470T-6	—
CSR903B-()-()	ST3M676-()-()
CSR903B3-4	ST3M676-3-4
CSR903B-4	ST3M676-4
CSR903B-4-()	ST3M676-4-()
CSR903B-4-8	ST3M676-()-()
CSR903B-4-14	ST3M676-4-()
CSR903B-5-()	ST3M676-5-()
CSR904B-6-()	ST3M675-()-()
CSR902B-5-()	ST3M718-5-()
CSR902B-3-()	—
CSR902B-4-()	—
CSR902B-3-4	ST3M718-3-4
CSR904B-3-()	—
CSR904B-4-()	—
CSR904B-5-()	—
CSR904B5-7	—
BRFZ4T()	—
BRFZ5E	—
BRFS4AD16	—
BRFS4AD()	—
BRFS4AD	—
BRFS4T()	—
BRFS5AD()	ST3M7485AD()
BRFS5E()	ST3M74853()
BRFS5T()	3M1022()
BRFS6T()	—
NAS1097AD()-()	—
NAS1097AD3	—
NAS1097AD4	—
NAS1097AD4-()	—
NAS1097AD5-()	—
NAS1097B3-()	—
NAS1097B10-6	—
NAS1097B12-6	—

Table 17. Nuts

Equivalent Part Number	McDonnell Standard Number
BN566-1032-1	—
NAS1734-3-1	—
NAS1734-3-3	—
NAS1743-3-4	—
NAS1291C08M	—
NAS1291C4M	—
NAS1291C6M	—
MS21042L3	—
LH10874-4	ST3M572-4M
HW49660-4	ST3M426C4M

Table 17. Nuts (Continued)

Equivalent Part Number	McDonnell Standard Number
H50609-4	—
LH11434-4	ST3M436-4M
—	ST3M404C4
E10080-4	ST3M404C4
AN315	—
78686-4	—
TLN1023CD3-LN	—
TLN1023CD3-6N	—
TLN1002CD3-5	—

Table 18. Bolts

Equivalent Part Number	McDonnell Standard Number
HT4008-4-5 thru 15	ST3M496-4-5 thru 15
HT4008-5-10 thru 20	ST3M496-5-10 thru 20
HT4024L4-()	ST3M455L4()-()
NAS674V6	—
NAS663V12	—
NAS663V12HT	—
NAS663V14	—
NAS663V14HT	—
NAS663V16	—
NAS663V18	—
NAS663V22	—
NAS664V21HT	—
NAS663V16HT	—
NAS663V18HT	—
NAS663V22HT	—
NAS6303L3	—
NAS6306U11	—
NAS6304U-()	—
NAS673V6	—
NAS673V7	—
NAS673V8	—
A1C763-4-20	—
A1C763-4-10	—
A1C763-4-12	—

Table 19. Hi-Torque Sealing Head Screw, 100° Countersink

Equivalent Part Number	McDonnell Standard Number
HT271A4-()	ST3M430V4-()
HT4025L3-2	—
HT4025L3-3	—

Table 20. Bushings

Equivalent Part Number	McDonnell Standard Number
—	ST4M166-10-108
—	ST4M219-07052
—	ST4M219-07053
—	ST4M219-05005
—	ST4M219-05006
—	ST4M219-05010
—	ST4M219-05011
—	ST4M219-05017
—	ST4M219-05018
—	ST4M219-05019
—	ST4M219-05020
—	ST4M0752
—	ST4M0753
—	4M106-10006
—	10M20-207
—	10M20-208
—	ST4M130-03010
—	74A331656-2001
—	74A331656-2003
—	74A331645-2001
—	74A331645-2003

Table 21. Retainers

Part Number
NAS578-14A
NAS578-8A

Table 21. Retainers (Continued)

Part Number
74R320103-2001 and -2002
1944-6

Table 22. Barrel Nuts, Floating

Equivalent Part Number	McDonnell Standard Number
SL405-8F	ST3M738-8
SL405-14FSP1	ST3M738-14N

Table 23. Huck Bolts

Part Number
MS90353-12-()D

Table 23. Huck Bolts (Continued)

Part Number
MS90353-14-()D
MS90354-12-()D

Table 24. Contact Strips, Electrical Bonding Strips

Equivalent Part Number	McDonnell Standard Number
— — — — — —	ST9M622-2 ST9M622-3 ST9M622-3-2400 ST9M622-4 ST9M622-5 ST9M622-6
LEGEND 1. 0.125 Offset. 2. Supplied in 24 inch lengths.	

Table 25. Sleeves

Equivalent Part Number	McDonnell Standard Number
JK5902C08N3B JK5902C08N4B JK5902C10N4B — JK9902C12N4B — 74A210803-2005 74A210803-2007	4M273C3-() 4M273C4-() 4M273C5-() 4M249C6-4 — 4M249()6() - -

Table 26. Cherry Rivets

Equivalent Part Number	McDonnell Standard Number
1247-()	3M219A()

Table 27. Lockbolt Pins

Part Number
NAS2605V05 NAS2605V() NAS2705V()

Table 28. Lockbolt Collars

Part Number
NAS1080AG05

Table 29. Bearings

Part Number
MS14101-12 MS14101-8 MS14101-16 MS14101-12 KWB10-41 KPD16-5 KSAD32-18 KSAD78-3 KSAD32-18 4M237-9

Table 30. Cotter Pins

Part Number
MS24665-13
MS24665-151
MS24665-153
MS24665-302
MS24665-86

Table 31. Fillers

McDonnell Part Number
74A360001-2087
74A360001-2089
74A360001-2091
74A360001-2093
74A360001-2099
74A360001-2101
74A360001-2103
74A360001-2105

Table 32. Supports

McDonnell Part Number
74A331366

Table 32. Supports (Continued)

McDonnell Part Number
74A331367
74A331368

Table 33. Spacers

McDonnell Part Number
74A330713
74A330755

Table 34. Plates

McDonnell Part Number
74A330754

Table 35. Pins

Part Number
123486-1
123486-2
123486-3
123486-4
3M1138-7

ORGANIZATIONAL MAINTENANCE

STRUCTURE REPAIR

IN-SERVICE TOLERANCES

Reference Material

Structure Repair, General Information	A1-F18AC-SRM-200
Adhesive, Cement, and Sealant; Preparation and Application	WP011 00

Alphabetical Index

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Contour Smoothness For Air Inlets and Associated Ducting.....	3

Record of Applicable Technical Directives

None

1. IN-SERVICE TOLERANCES.

2. This work package lists in-service tolerances required to assist repairs detailed in structure repair series manuals. Areas to be covered are; permissible wear tolerance in excess of manufacturing tolerances, permissible misalignment in excess of manufacturing tolerances, permissible step-gap and mismatch tolerances, exterior surface critical contour tolerances, reaming and bushing tolerances, and allowable clearances.

3. CONTOUR SMOOTHNESS FOR AIRCRAFT

MOLD LINE. Contour smoothness requirements for aircraft shall be maintained for aerodynamic and flight characteristics. All requirements of this paragraph were established at time of aircraft manufacture. Exceptions to established requirements may exist because of repair, rework or replacement of specific structural item(s) on airframe. If exceptions are evident, applicable structure repair manual shall take precedence.

WARNING

Damage or repairs which disturb smooth flow of air over critical areas of wing will reduce lift. This may cause only slight wing heavy condition or it could affect stall characteristics which will affect takeoff and landing pattern speeds. It could also cause buffeting at high speeds. Changes to airflow around critical areas of control surfaces may affect control effectiveness.

Damage or repairs that change contour or roughen surface will cause reduction in performance of aircraft. In aerodynamically critical areas, every effort shall be made to maintain original contour and smoothness requirements or performance of the aircraft will be seriously affected. Contour smoothness requirements shall be met without application of aerodynamic fairing compound unless otherwise stated.

4. Requirements.

a. Flush fasteners shall be flush with mold line surface within limits of figure 1. Milling flush rivet heads is allowed to meet these limits.

b. Allowable mismatch at butt joints for aerodynamic zones I, II, or III. Mismatch is classified into three types, see figure 2.

c. Paint ridges shall be faired to contour.

5. Butt Joint Gaps.

a. Tolerances on gaps at butt joints are given as maximum (MAX) allowable; minimum shall be 0.0 unless other dimensions are given, see figure 3.

b. All windshield and canopy gaps shall be filled smooth (WP011 00).

6. Tolerances.

a. Butt gap and mismatch, see figure 1.

b. Maximum exterior contour deviations in zones I and II shall not exceed +0.020 or -0.040 inch and in zone III +0.030 or -0.050 inch. These tolerances do not apply between attach or joint areas governed by mismatch tolerances listed in figure 1.

c. Surface waviness in zone I, II, or III shall be measured in water line, ± 0.5 , and buttock line, ± 0.5 , planes only and shall not exceed 0.015 inches from peak-to-valley in 6 inch span.

d. Surface Roughness, see figure 1.

7. Rework.

a. Method:

(1) Mismatch conditions within allowable tolerances may be reworked, see figure 4.

(2) Mismatch conditions exceeding allowable tolerance shall be submitted for depot engineering disposition.

(3) All gaps exceeding conditions of figure 3 shall be rejected and submitted for depot engineering disposition.

(4) Waviness rework exceeding tolerance requirements of paragraph 6 requires depot engineering approval. Except as limited by paragraph 7, waviness shall be reworked by filling with sealant or aerodynamic filler.

b. Limits.

(1) Aerodynamic filler shall not be applied in head slots of fasteners, quick release slots, or gaps of joints associated with moveable or readily removeable panels/doors. Sealant shall not be applied to mechanical doors without engineering approval.

(2) Aerodynamic filler shall not be applied to fuselage between Y357.5 and Y450.0 and lower sheer to Z112.00.

8. Antenna Replacement Covers. Smoothness, gap, and mismatch requirements for antenna covers are listed below:

a. Gap and mismatch tolerances, see figure 1.

b. Maximum exterior contour deviations, refer to paragraph 6.

c. Surfaces of antenna covers shall be uniformly smooth and free from voids, gaps, cracks, holes, blisters, porosity, wrinkles, delamination, variable density areas, soft spots, unbonded areas, or other defects.

d. Antenna covers requiring erosion coating must meet tolerance and waviness requirements of paragraph 6.

e. Patched areas of antenna covers shall conform to tolerances specified in paragraph 6.

9. Windshield and Canopy Transparencies.

Contour, gap, and mismatch requirements for windshields and canopy transparencies are maximum allowances unless given specific deviations for particular application and apply only to that windshield or canopy transparency on that aircraft.

a. Edging strips shall be uniformly smooth and free from voids, cracks, holes, air and gas pockets, blisters, porosity, resin pockets, areas lacking resin, wrinkles, delaminations, variable density areas, soft spots, uncured or unbonded areas, paper tape, and other defects.

b. Mismatch allowances, see figure 1.

c. All patches shall conform to tolerance of this work package.

10. CONTOUR SMOOTHNESS FOR AIR INLETS AND ASSOCIATED DUCTING. See Figure 5.

Contour smoothness, gap, and mismatch tolerance for all air inlet and associated ducting surfaces are listed below.

11. Requirements.

a. Fasteners.

(1) Only flush fasteners are permitted in air inlets and associated ducting.

(2) Milling flush rivets is allowed to meet flush tolerances. See figure 5.

(3) Flush fasteners shall be measured for excess variation in curved surface or angled with surface installations, see figure 6.

b. Mismatch.

(1) Mismatch is classified into three types, see figure 2.

(2) Mismatch shall be within the limits of table 1.

Table 1. Maximum Allowable Mismatch For Air Inlets And Associated Ducting

Type Of Mismatch	Zone I		Zone II		Zone III
FORWARD	0.005	(0.010 max., length not to exceed 25 percent of each skin splice)	0.010	(0.015 max., length not to exceed 25 percent of each skin splice)	0.020
AFT	0.010	(0.015 max., length not to exceed 25 percent of each skin splice)	0.015	(0.020 max., length not to exceed 25 percent of each skin splice)	0.025
PARALLEL	0.015		0.020		0.030

c. Butt Joint Gaps.

(1) Figure 7 shows types of butt joints, methods of measuring gap (G), and limitations on chamfering required to avoid interference.

(2) Butt joint gaps are classified into two conditions; condition 1 similar materials and condition 2 dissimilar materials, see table 2.

(3) Butt joint gaps shall be in limits of table 2.

d. Sealant.





(1) All skins are fay surface and butt joint sealed.

(2) No sealant shall protude above skin surface, air inlet mold line.

(3) All permanently installed skin fasteners are wet installed.

e. Aerodynamic fairing compounds or filler materials, except as used in paragraph 11, are not allowed in the air inlets and associated ducting.

Table 2. Allowable Transverse or Longitudinal Gap (G) For Air Inlets And Associated Ducting

Zone	G - Condition 1 Similar Materials	G - Condition 2 Dissimilar Materials
 1		
I	0.030 Max.	0.030 Min. - 0.060 Max.
II	0.040 Max.	0.030 Min. - 0.070 Max.
III	0.060 Max.	0.030 Min. - 0.090 Max.
 2		
ALL	0.060 Max.	0.030 Min. - 0.090 Max.
 Transverse Gap  Longitudinal Gap		

12. Smoothness Tolerances.

a. Fasteners shall be flush with duct surface within limits specified in figure 1.

b. Mismatch shall be within limits specified in table 1 and paragraph 11.

c. Contour deviations in zones I and II shall not exceed $\pm 0.030^\circ$ ba inch and in zone III $\pm 0.040^\circ$ ba inch. These tolerances do not apply at duct skin butt joint areas which are covered by mismatch tolerance listed in table 1.

d. Surface waviness in zone I, II, or III shall be measured at water line, $\pm 0.5^\circ$ and buttock line, $\pm 0.5^\circ$, planes only and shall not exceed; 0.015 inch from peak-to-valley in 6 inch area for zone I, 0.020 inch from peak-to-valley in 6 inch area for zone II, and 0.030 inch from peak-to-valley in 6 inch area for zone III.

e. Surface Roughness, see figure 1.

13. Rework.

a. Mismatch.

(1) Mismatch conditions that exceed limitations of table 1 may be reworked per figure 8.

(2) Mismatch conditions not covered shall be submitted for depot engineering disposition.

b. If gaps specified in table 2 are exceeded, affected parts shall be rejected and submitted for depot engineering disposition.

c. Waviness rework that exceeds paragraph 12 shall be submitted for depot engineering disposition.

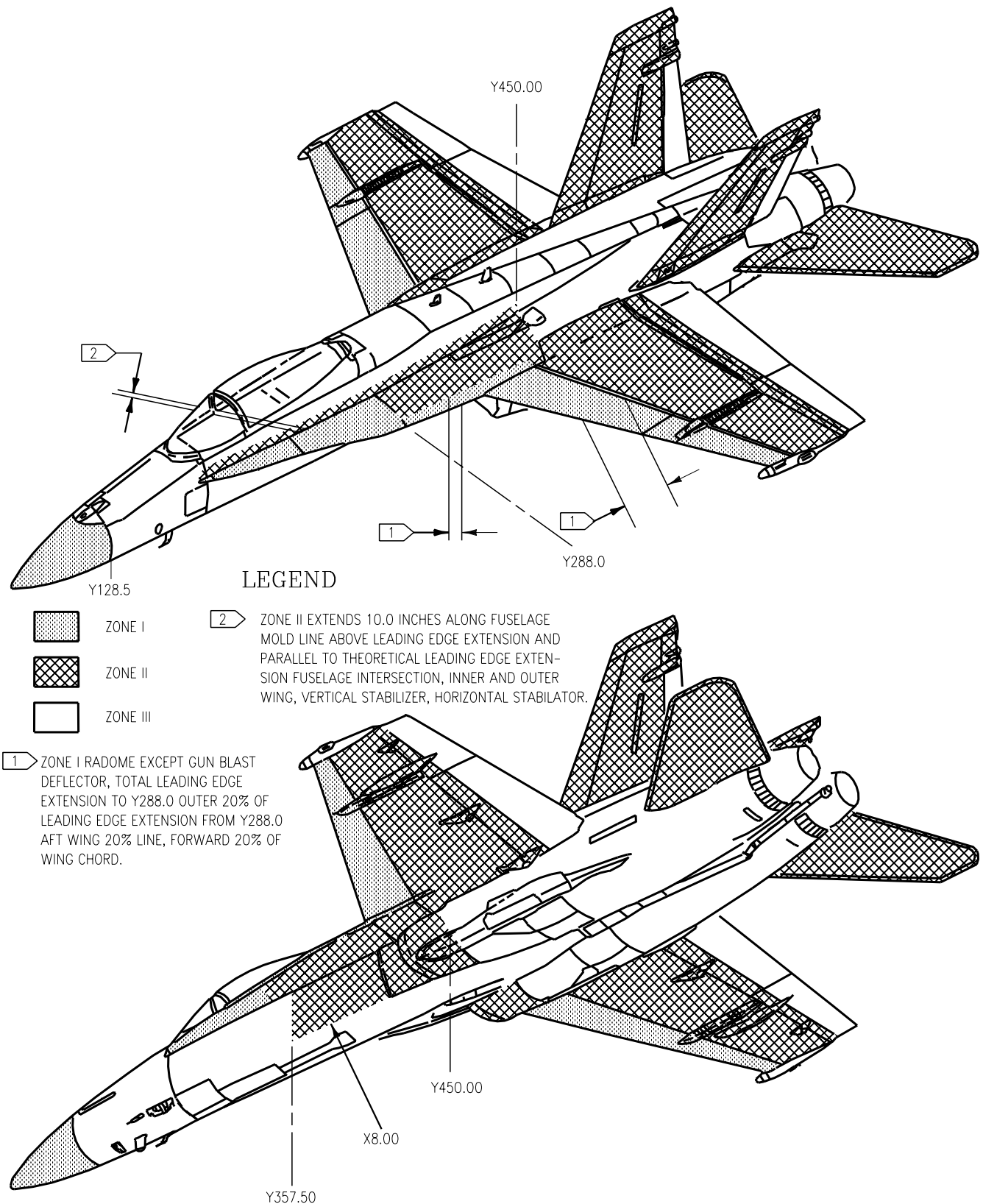


Figure 1. Aerodynamic Zones (Sheet 1)

TOLERANCES FOR CONTOUR SMOOTHNESS IN AERODYNAMIC ZONES I, II AND III








SUBJECT		AERO DYNAMIC ZONES		
		I	II	III
FLUSH ALUMINUM RIVETS (MACHINE COUNTERSUNK)		+0.002 —0.001	+0.002 —0.001	+0.002 —0.001
FLUSH RIVETS OTHER THAN ALUMINUM.		N/A	+0.007 —0.001	+0.007 —0.001
QUICK RELEASE FASTENERS (MACHINE COUNTERSUNK)		N/A	±0.005	±0.005
FLUSH FASTENER OTHER THAN ITEMS 1, 2, AND 3		+0.006 —0.004	0.006 —0.004	+0.006 —0.004
MAXIMUM MISMATCH AT PERMANENT BUTT JOINTS, EXCEPT AS NOTED OTHERWISE	FORWARD AFT PARALLEL	0.005 0.010 	0.015 0.020 0.030	0.020 0.030 0.030
MAXIMUM MISMATCH AT REMOVABLE PANELS, MAJOR JOINTS, SPLICES, MECHANICAL DOORS, LATCHES, HINGE HALVES, AND EXTERNAL HANDLES EXCEPT AS NOTED OTHERWISE. 	FORWARD AFT PARALLEL	0.010 0.015 	0.030 0.030 0.030	0.040 0.040 0.040
MAXIMUM GAP AT BUTT JOINTS SEE FIGURE 3. CONDITIONS APPLY TO SIMILAR MATERIALS EXCEPT CONDITION 28. THIS CONDITION IS DISSIMILAR MATERIALS.				
MAXIMUM MISMATCH FOR ANTENNA AND NAVIGATION LIGHT	FORWARD AFT PARALLEL	0.020 0.025 0.025	0.030 0.030 0.030	0.035 0.035 0.035
MAXIMUM MISMATCH FOR WINDSHIELD AND CANOPY TRANSPARENCIES	FORWARD AFT	N/A N/A	N/A N/A	N/A N/A
MAXIMUM MISMATCH AT INTERCHANGEABLE LAUNCHER ASSEMBLY MOLD LINE AT SURFACE MOLD LINE	FORWARD AFT PARALLEL	N/A N/A N/A	0.080 0.100 0.080	0.080 0.100 0.080
SURFACE FINISH, RHR, BEFORE PAINTING		125	125	125
 PARALLEL MISMATCH FACING INBOARD SHALL BE TREATED AS AFT MISMATCH, PARALLEL MISMATCH FACING OUTBOARD SHALL BE TREATED AS FORWARD MISMATCH.  A MAXIMUM OF 35 PERCENT OF ALUMINUM RIVETS, IN A ROW OR PATTERN, ARE ACCEPTABLE TO FLUSHNESS TOLERANCE OF PLUS 0.005 INCH TO MINUS 0.001 INCH.  163985 AND UP, DORSAL DECK DOORS, 18, 26, 31, 43, AND 49, IN ZONE III HAVE AN ALLOWABLE FORWARD, AFT AND PARALLEL MISMATCH OF 0.090 IN AN AREA 6 INCHES FORWARD AND 6 INCHES AFT FROM EACH END OF COVER. BETWEEN DOORS 18 AND 26, AN AFT-FACING MISMATCH OF 0.100 IS PERMISSIBLE WITHIN AN AREA 5.50 INCHES FROM EACH SIDE OF THE AIRCRAFT CENTERLINE. IF MISMATCH IS DISCOVERED, THE FOLLOWING CONDITIONS MAY BE CONTRIBUTORS: PAINT AND/OR SEALANT BUILD-UP, DAMAGED TAPES AND/OR COATINGS ON THE IML OR OML, AND DOOR DAMAGE (DELAMINATION). CORRECT IRREGULARITIES BEFORE MEASURING MISMATCH.				

Figure 1. Aerodynamic Zones (Sheet 2)

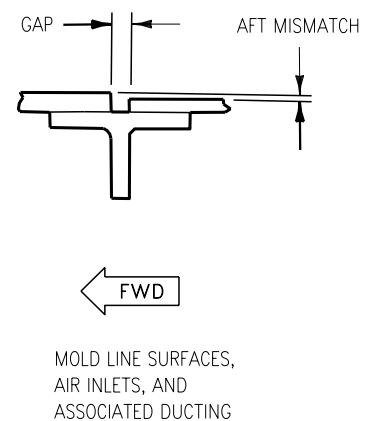
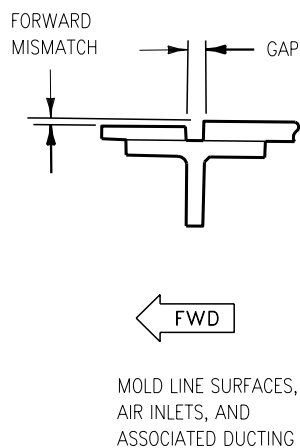
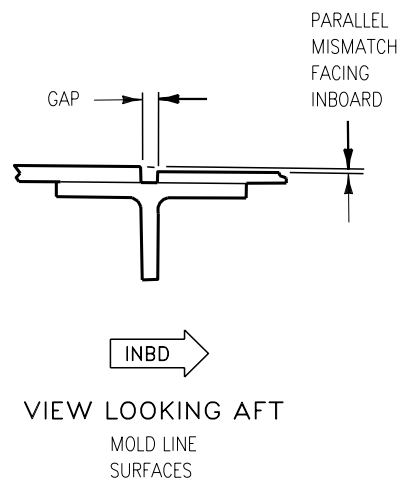
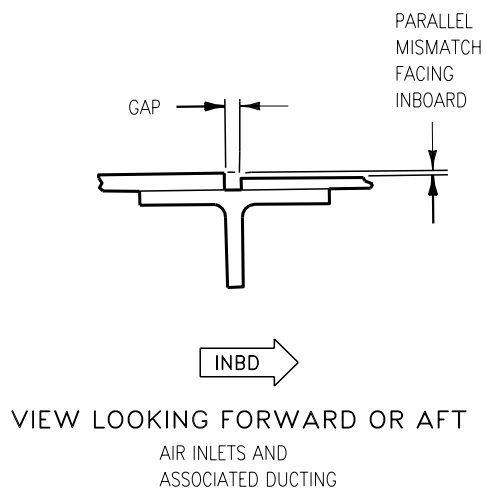


Figure 2. Types of Mismatch

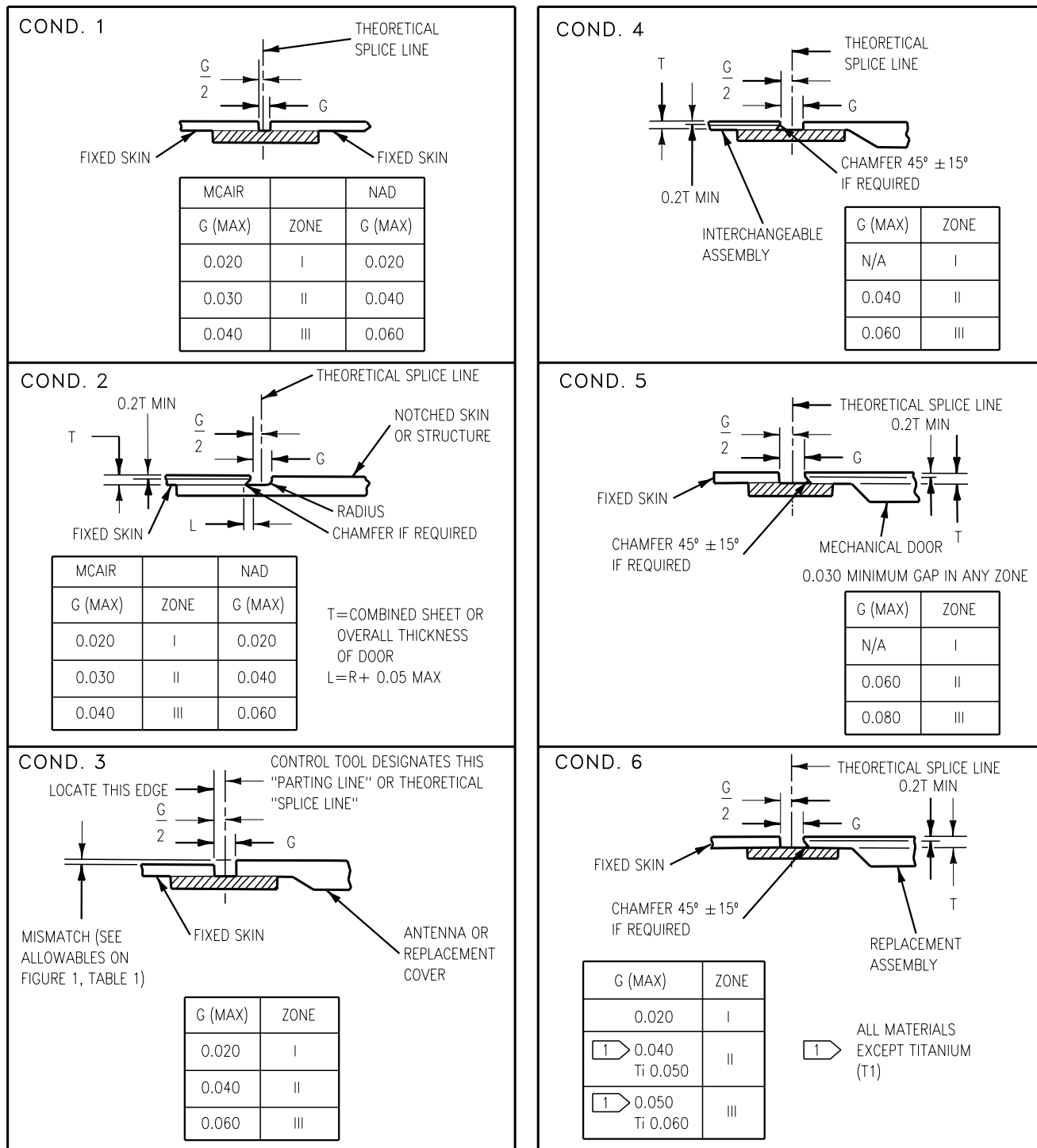


Figure 3. Gaps at Butt Joints (Sheet 1)

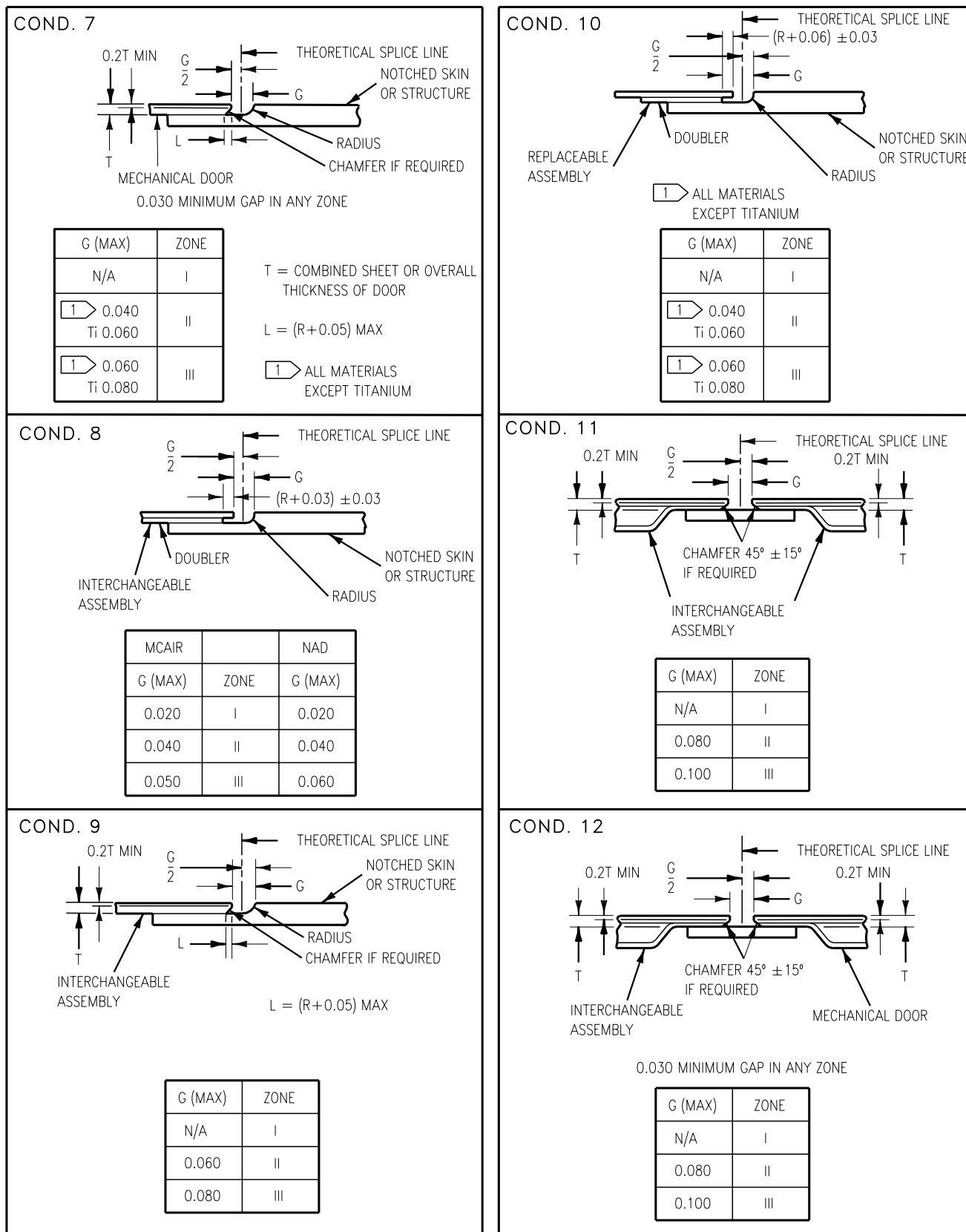


Figure 3. Gaps at Butt Joints (Sheet 2)

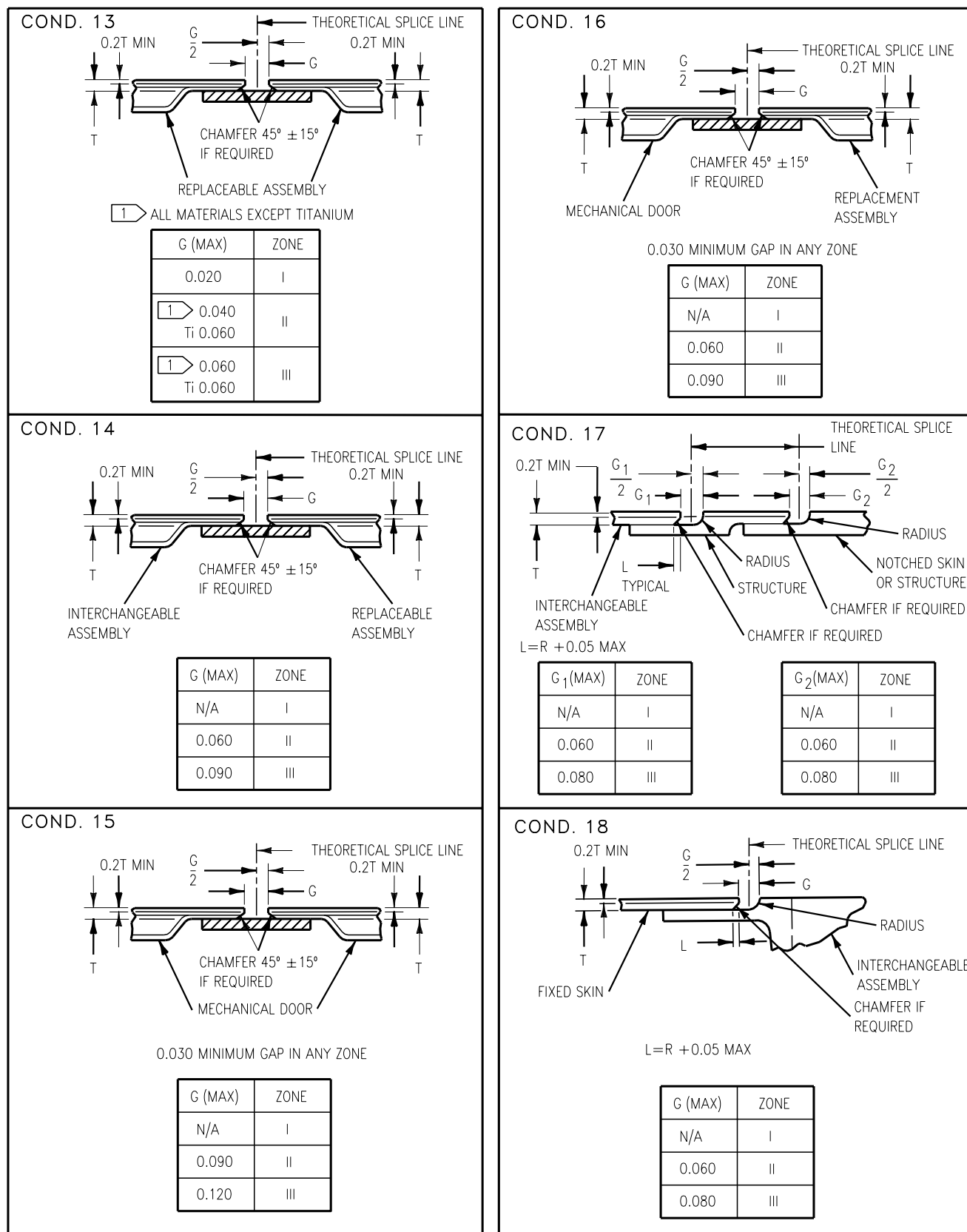


Figure 3. Gaps at Butt Joints (Sheet 3)

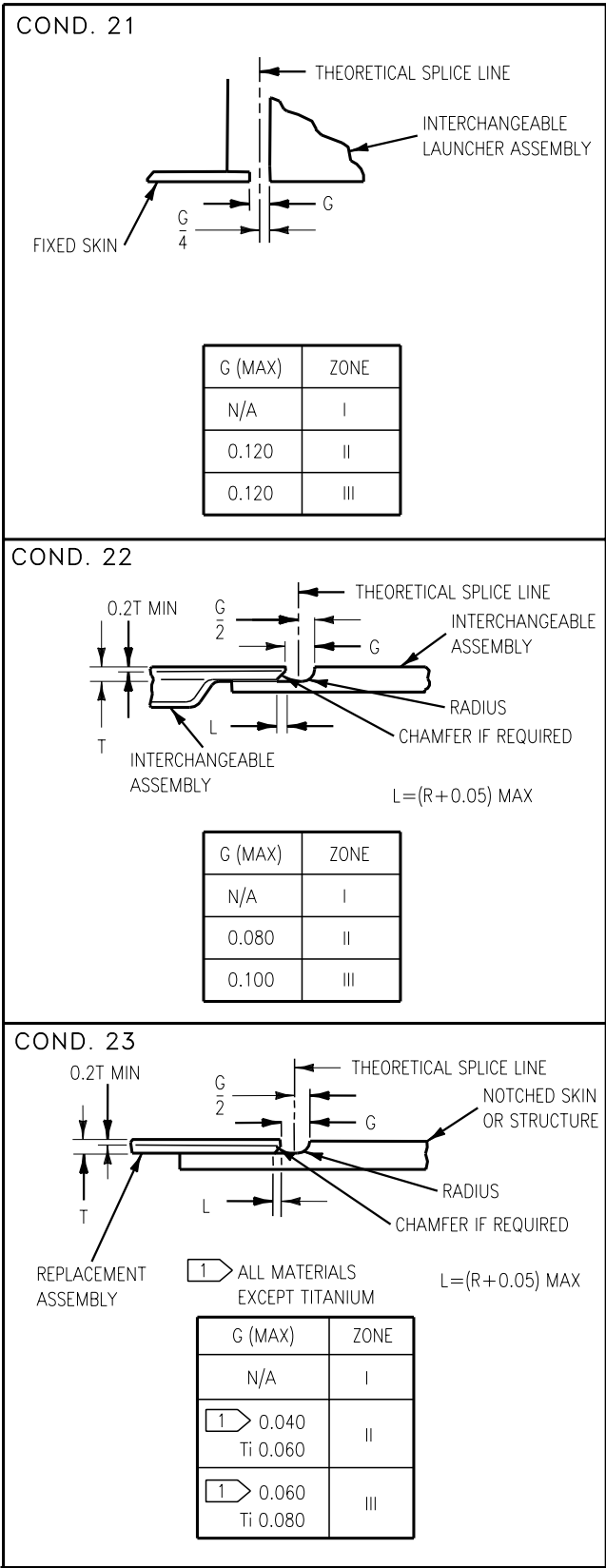
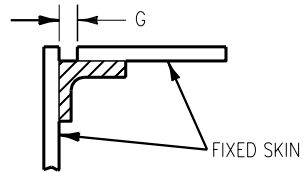


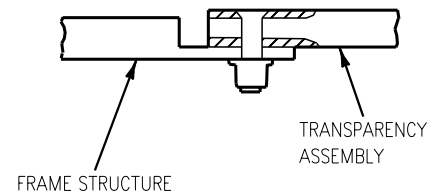
Figure 3. Gaps at Butt Joints (Sheet 4)

COND. 24

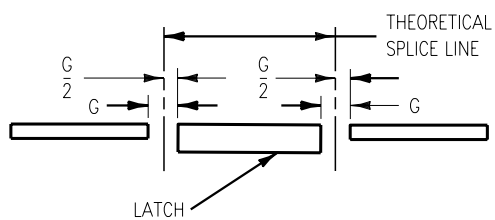


G (MAX)	ZONE
N/A	I
0.030	II
0.040	III

COND. 27



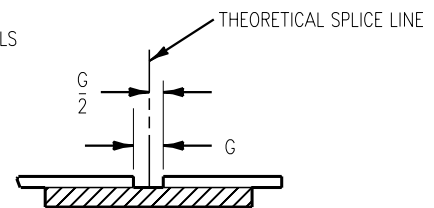
COND. 25



G (MAX)	ZONE
N/A	I
0.030	II
0.030	III

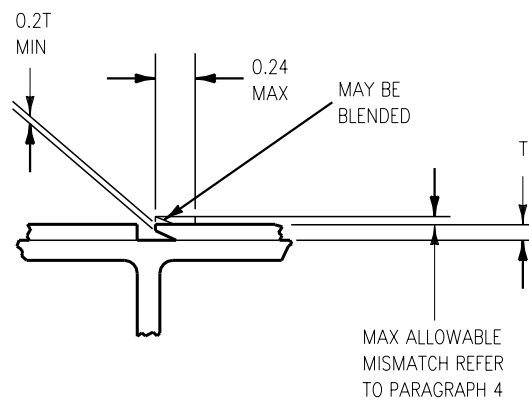
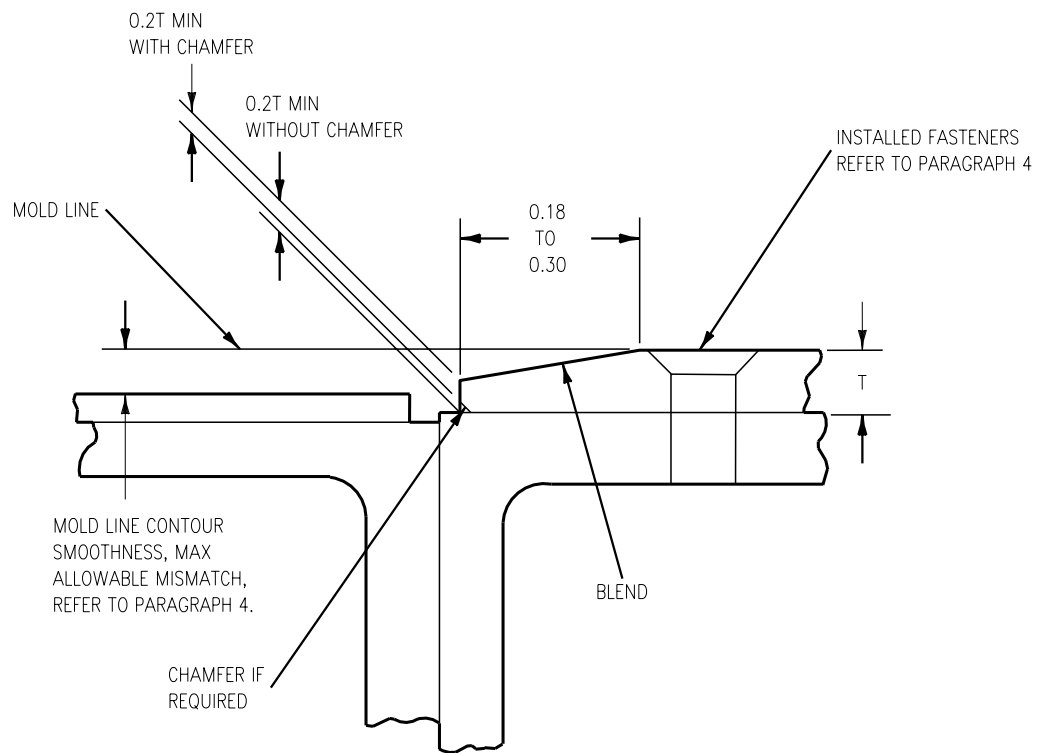
COND. 28

DISSIMILAR MATERIALS



GAP	ZONE
0.060 MIN 0.140 MAX	ALL

Figure 3. Gaps at Butt Joints (Sheet 5)

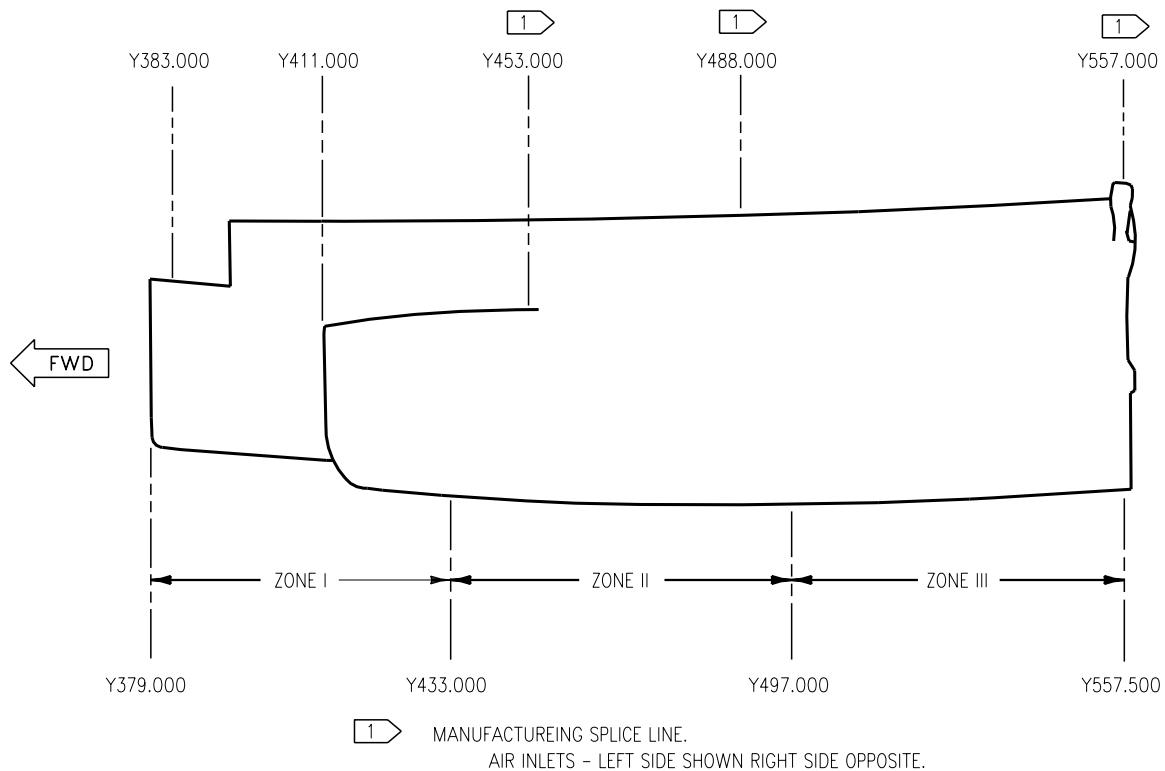


ALLOWABLE REPAIR FOR EXCESSIVE MISMATCH

LEGEND

T=COMBINED SHEET OR OVERALL THICKNESS.

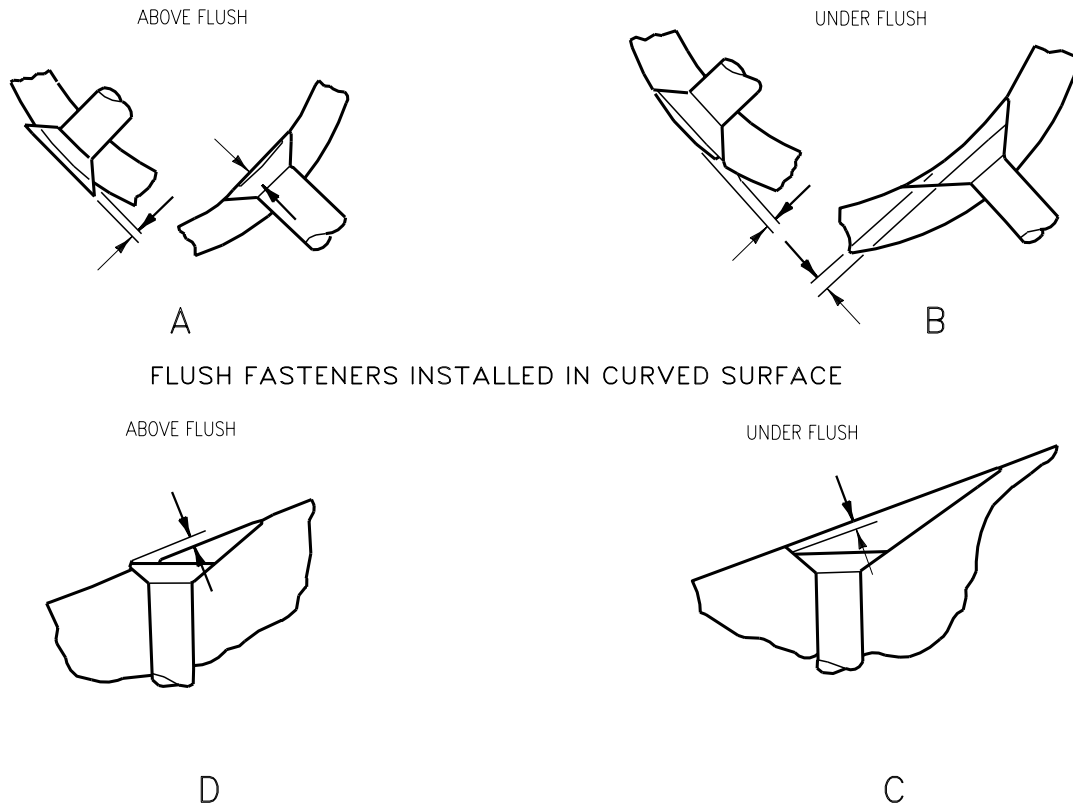
Figure 4. Mold Line Mismatch Rework



AIR INLET AND ASSOCIATED DUCTING SMOOTHNESS ZONES

INLET	ZONE NUMBER		
FUNCTION	I	II	III
MAIN ENGINE AIR INLET AND DUCT	Y379.000 TO Y433.000	Y433.000 TO AND INCLUDING THE TRANSVERSE SPLICE AT Y497.000	Y497.000 TO AND INCLUDING THE TRANSVERSE SPLICE AT Y557.500
ENGINE BAY VENT INLET			X
ECS HEAT EXCHANGER INLETS		X	
LCS HEAT EXCHANGER INLET		X	
HYDRAULIC SYSTEM HEAT EXCHANGER INLET			X
GUN BAY PURGE INLET			X

Figure 5. Air Inlet and Associated Ducting Smoothness Zones



FLUSH FASTENERS INSTALLED IN CURVED SURFACE

FLUSH FASTENERS INSTALLED AT AN ANGLE WITH THE SURFACE

RIVET SMOOTHNESS TOLERANCE

ITEM	TYPE RIVET	OVER FLUSH	UNDER FLUSH
A	ALUMINUM OTHER THAN ALUMINUM	0.002 0.005	0.000 0.000
B	ALUMINUM OTHER THAN ALUMINUM	0.002 0.005	0.000 0.000
C	ALUMINUM OTHER THAN ALUMINUM	0.002 0.005	0.000 0.000
D	ALUMINUM OTHER THAN ALUMINUM	0.002 0.005	0.000 0.000
35% OF ALL RIVETS MAY GO TO 0.005 OVER FLUSH OR 0.001 UNDER FLUSH.			

Figure 6. Fastener Tolerance for Air Inlets and Associated Ducting Surfaces

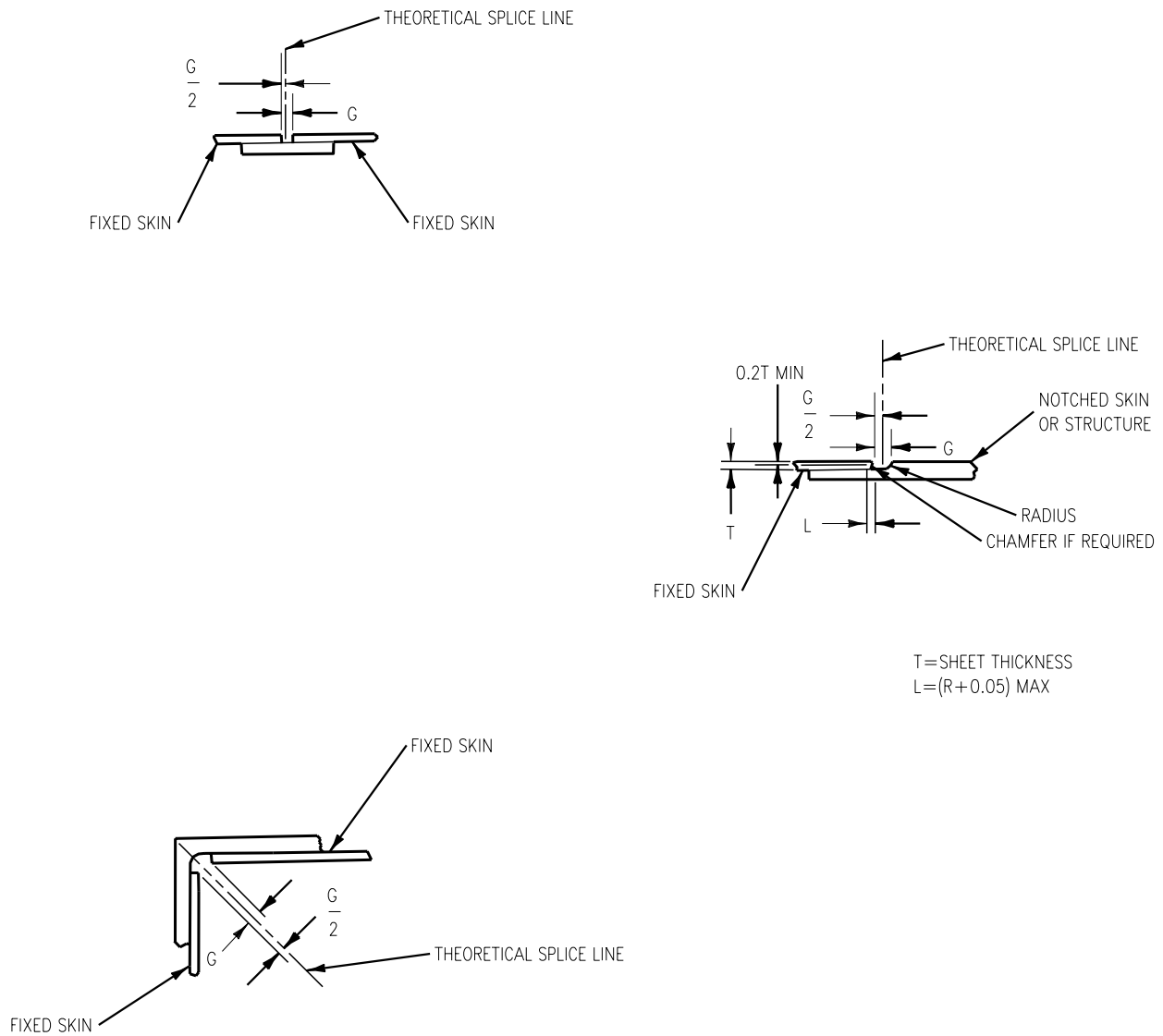
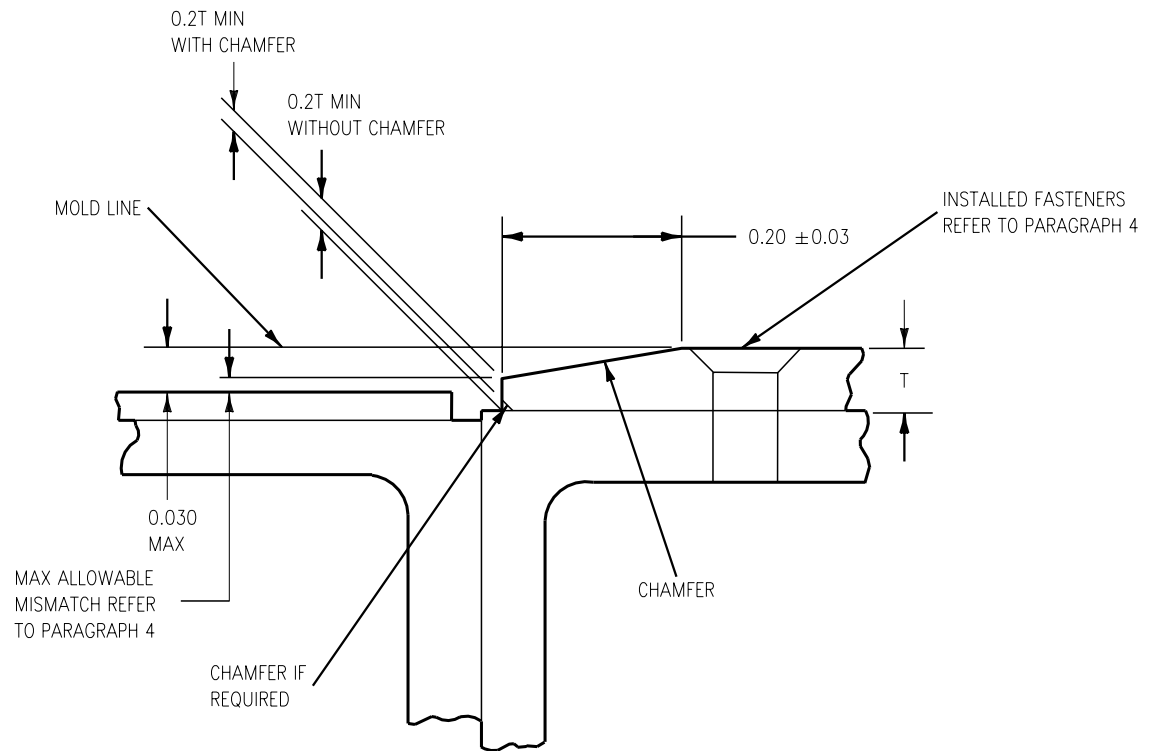


Figure 7. Types of Butt Joint Gaps



ALLOWABLE REPAIR FOR EXCESSIVE MISMATCH; FORWARD, AFT, OR PARALLEL

Figure 8. Air Inlets and Associated Ducting Mismatch Repair

INTERMEDIATE MAINTENANCE

STRUCTURAL REPAIR

CRASH HANDLING

REMOVAL OF AIRCRAFT FROM CRASH SITE

Reference Material

Plane Captain Manual	A1-F18AC-PCM-000
Line Maintenance Procedures.....	A1-F18AC-LMM-000
Landing Gear and Related Systems.....	A1-F18AC-130-200
Landing Gear System.....	WP003 00
Landing Gear and Related Systems.....	A1-F18AC-130-300
Removal and Installation - NLG Cylinder and Piston Assembly	WP019 00
MLG Shock Absorber.....	WP039 00
Structure Repair, General Information	A1-F18AC-SRM-200
Aircraft Lifting Bags	WP010 01

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One or More Landing Gear Sheared	3
Safety Precautions	1
Safety Precautions for Carbon Epoxy Fibers	1

Record of Applicable Technical Directives

None

1. SAFETY PRECAUTIONS.



Every attempt must be made to keep crash damaged aircraft from additional damage.

a. Make sure battery switch is in OFF position (A1-F18AC-LMM-000).

b. Install ground safety devices required during all ground operations or maintenance (A1-F18AC-PCM-000).

c. Defuel aircraft (A1-F18AC-PCM-000).

d. Remove liquid oxygen converter (A1-F18AC-LMM-000).

2. SAFETY PRECAUTIONS FOR CARBON EPOXY FIBERS.

a. Close all windows, doors, ventilation openings, and other access to outside when carbon

epoxy fibers (CFs) accidents occur in or around shop/hanger area.

b. Turn off non-essential electrical equipment until cleanup is completed.

c. Restrict passage of personnel into and out of areas containing electric equipment for duration of cleanup.

d. CFs act as irritants similar to fiberglass, when present in moderate to heavy amounts:

(1) Personnel should be provided dust masks, gloves, and eye protection.

(2) Eating, drinking, and smoking should be prohibited.

e. CFs have low electrical resistance values and are influenced by high voltage circuits.

f. Vacuum bags and filters, effluent filters, contaminated equipment filters, and collected CFs/residue shall be placed in plastic bags, sealed, and disposed of by burial. Bags should be marked 'carbon fiber debris, do not incinerate, do not sell for scrap, dispose of in landfill only. At sea, bags shall be retained for shore disposal.

g. Before moving wreckage/debris, immobilize loose/exposed CFs using suitable plastic sheeting.

h. Secure planned transport route by closing aircraft canopies and access doors and by installing aircraft inlets/exhaust covers. In addition, doors and windows of buildings along transportation route should be closed.

i. Tow wreckage carefully to prevent spreading CFs. Spray fixit on suspect areas of aircraft, soil, and hard surfaces to reduce CFs hazard.

3. REMOVAL.

Support Equipment Required

Part Number or Type Designation	Nomenclature
MIL-W-4088	Nylon Strap, 8.00 Inches Wide

Materials Required

Specification or Part Number	Nomenclature
—	Wooden Planks 48 X 144 inches As Required
—	Wire Rope, 1 inch
—	Steel Angle 4.0 X0.125 2 Required
—	Eye Bolts 4 Required
—	Flush Head Steel Bolts, 3/4 X9 24 Required
—	Turnbuckle 4 Required

NOTE

Air bags are used to get aircraft high enough to position jacks or to position sled transportation rig (sled). Do not leave aircraft on airbags.

a. Lift the aircraft with air bag(s) (WP010 01).

b. Position jack(s) as required (A1-F18AC-LMM-000).

c. Try to extend landing gear (A1-F18AC-130-200, WP003 00).

NOTE

If all landing gear will not extend, go to paragraph 4. If one or more gear is sheared, go to paragraph 5. If landing gear extends, continue with step d.

d. Install ground safety devices required (A1-F18AC-PCM-000).

e. Lower and remove jack(s) (A1-F18AC-LMM-000).

f. Lower and remove air bag(s) (WP010 01).

g. Tow aircraft to maintenance area.

4. ALL LANDING GEAR WILL NOT EXTEND.

a. Retract extended landing gear (A1-F18AC-130-200, WP003 00).

NOTE

If landing gear does not retract per step a, do step b.

b. Retract landing gear manually so aircraft can be lowered onto sled.

c. Lower and remove jack(s) (A1-F18AC-LMM-000).

d. Position sled, see figure 1.

e. Lower and remove air bag(s) (WP010 01).

f. Moor aircraft to sled, see figure 2.

g. Tow aircraft to maintenance area.

5. ONE OR MORE LANDING GEAR SHEARED.

NOTE

If replacement landing gear is not available, go to step f.

a. Remove remainder of sheared landing gear and install replacement landing gear (A1-F18AC-130-300, WP019 00 or WP039 00).

b. Install ground safety devices required (A1-F18AC-PCM-000).

c. Lower and remove jack(s) (A1-F18AC-LMM-000).

d. Lower and remove air bag(s) (WP010 01).

e. Tow aircraft to maintenance area.

f. If replacement landing gear is not available, remove remainder of sheared landing gear.

g. Do paragraph 4, steps a through g.

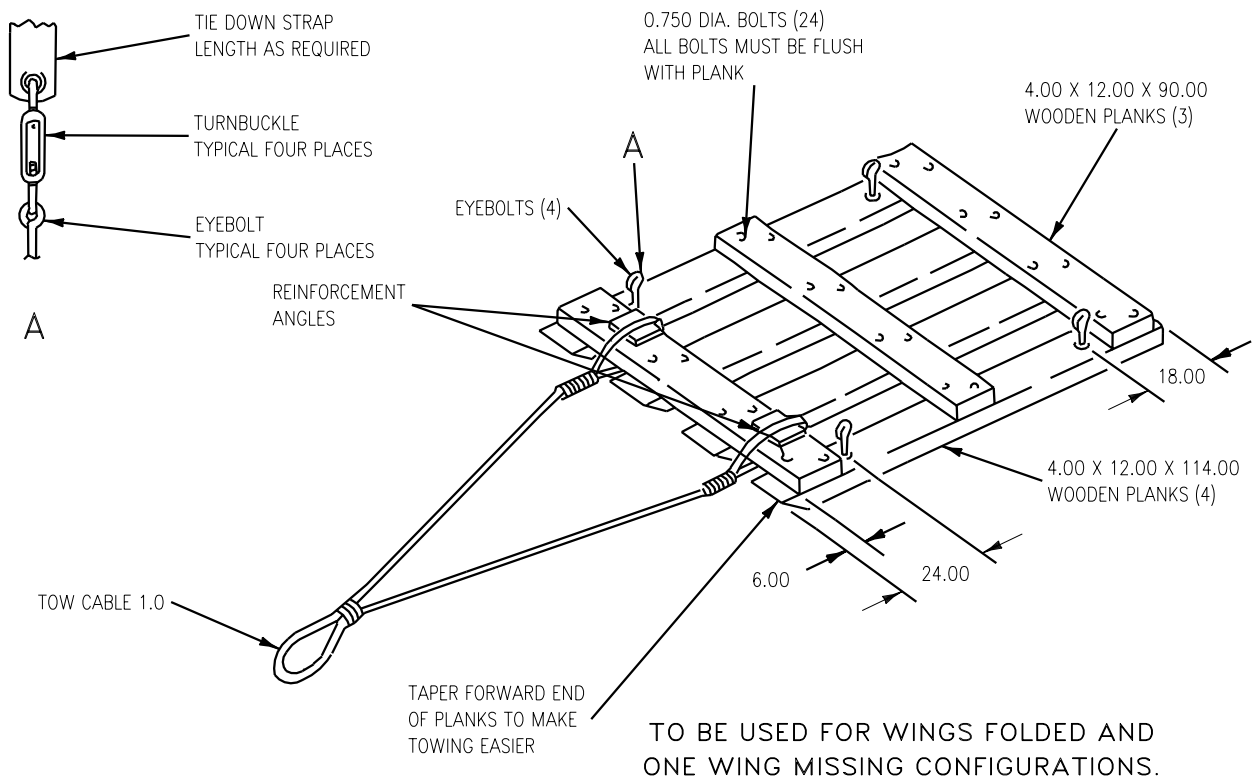
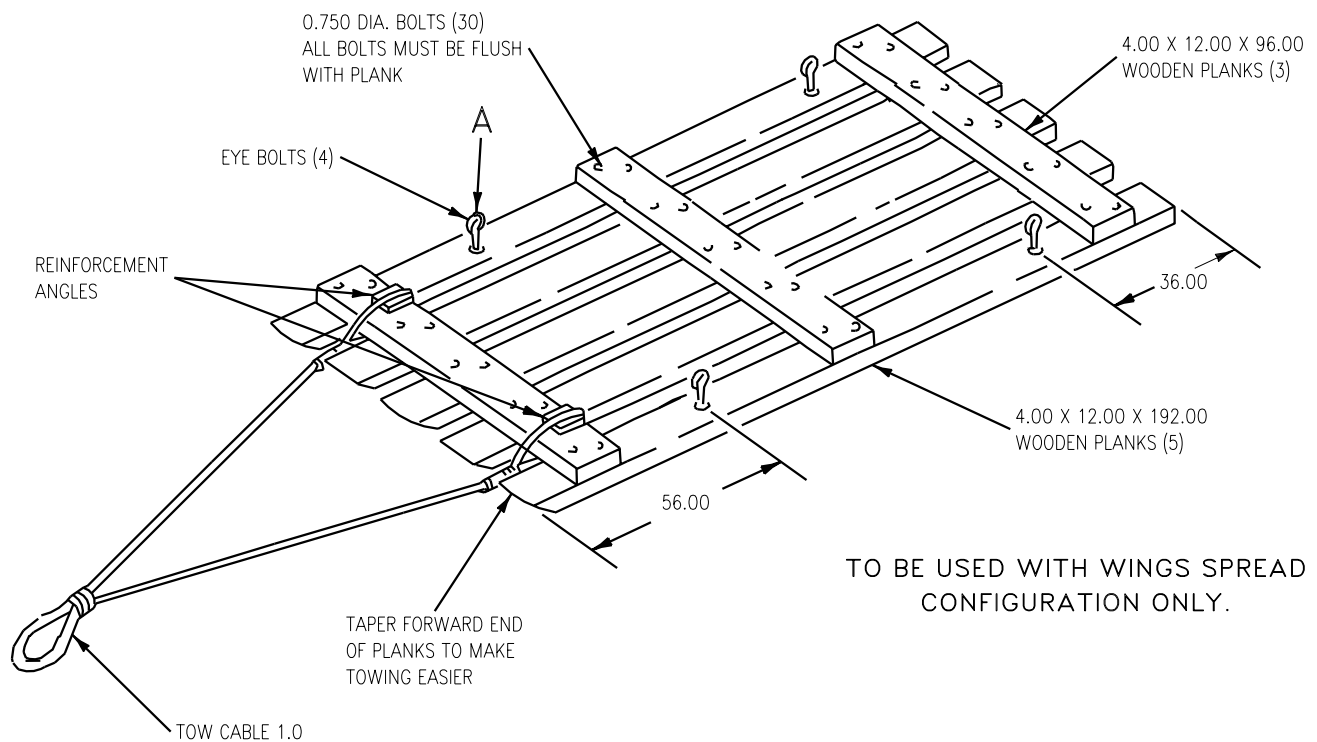


Figure 1. Sled Transportation Rig

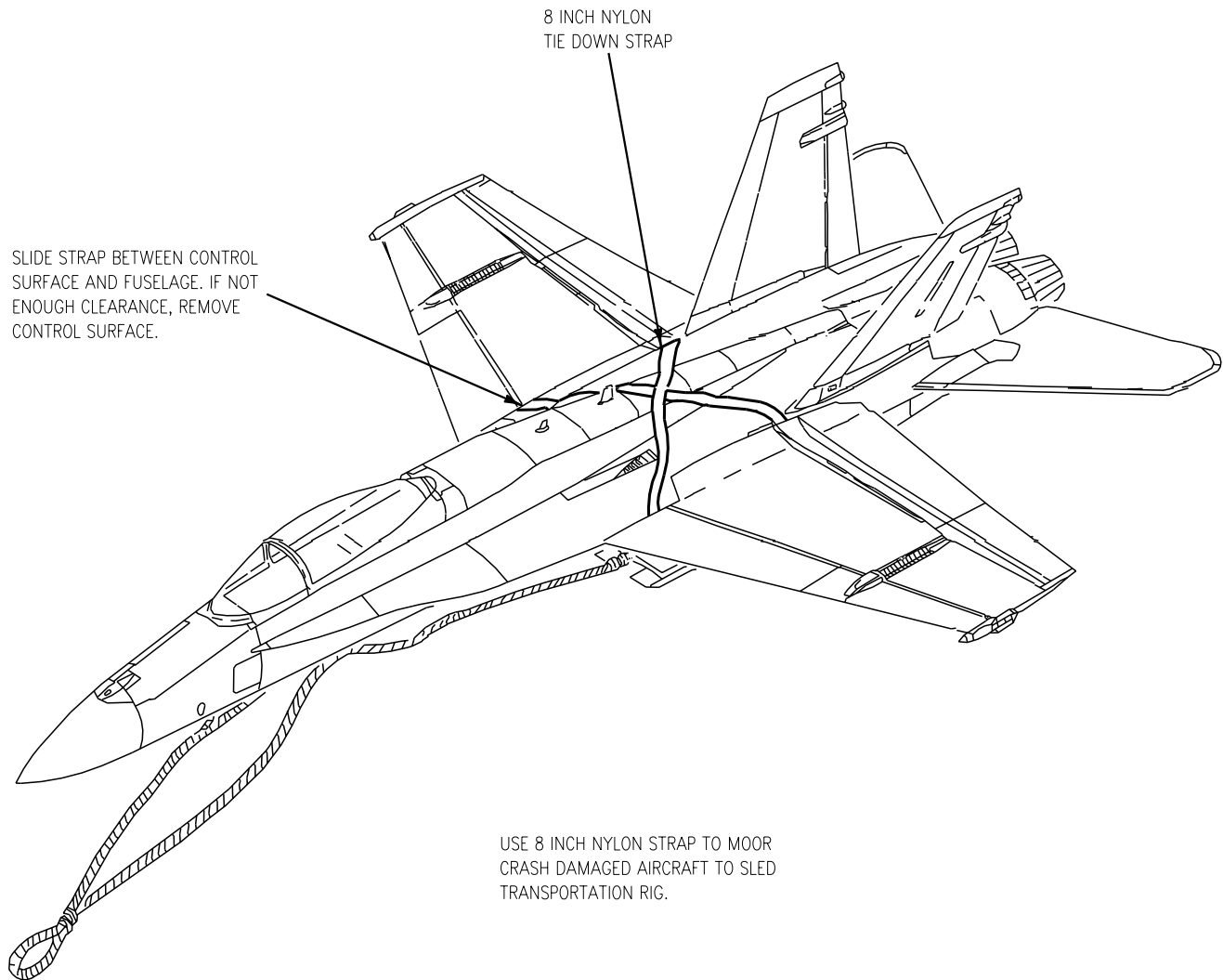


Figure 2. Mooring Aircraft to Sled Transportation Rig

INTERMEDIATE MAINTENANCE
STRUCTURE REPAIR**CRASH HANDLING****AIRCRAFT LIFTING BAGS**

Reference Material

Plane Captain Manual	A1-F18AC-PCM-000
Structure Repair, Forward Fuselage	A1-F18AC-SRM-220
Radome Replacement.....	WP003 03
Structure Repair, Forward Fuselage	A1-F18AE-SRM-650
Radome Replacement.....	WP006 00
Structure Repair, General Information	A1-F18AC-SRM-200
Hoisting and Mooring Aircraft	WP010 02
Line Maintenance Procedures.....	A1-F18AC-LMM-000

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Inflating Air Bags.....	7
Lifting Forward Fuselage to Position Air Bag.....	5
One Complete Wing Missing.....	4
Outer Wings Folded or Missing.....	3
Rolling Tilted Aircraft to Upright Position	6
Safety Precautions	2
Safety Precautions For Carbon Epoxy Fibers	2

Record of Applicable Technical Directives

None

1. SAFETY PRECAUTIONS.



Every action must be taken to keep crash damage aircraft from additional damage.

a. Make sure battery switch is in OFF position (A1-F18AC-PCM-000).

b. Make sure ground safety devices required during ground operations or maintenance are installed (A1-F18AC-PCM-000).

c. Defuel aircraft (A1-F18AC-PCM-000).

d. Remove liquid oxygen converter (A1-F18AC-LMM-000).

2. SAFETY PRECAUTIONS FOR CARBON EPOXY FIBERS.

a. Close all windows, doors, ventilation openings, and other access to outside when carbon epoxy fibers (CFs) accidents occur in or around shop/hanger area.

b. Turn off non-essential electrical equipment until cleanup is completed.

c. Restrict passage of personnel into and out of areas containing electric equipment for duration of cleanup.

d. CFs act as irritants similar to fiberglass, when present in moderate to heavy amounts:

(1) Personnel should be provided dust masks, gloves, and eye protection.

(2) Eating, drinking, and smoking should be prohibited.

e. CFs have low electrical resistance values and are influenced by high voltage circuits.

f. Vacuum bags and filters, effluent filters, contaminated equipment filters, and collected CFs/residue shall be placed in plastic bags, sealed, and disposed of by burial. Bags should be marked 'carbon fiber debris, do not incinerate, do not sell for scrap, dispose of in landfill only. At sea, bags shall be retained for shore disposal.

g. Before moving wreckage/debris, immobilize loose/exposed CFs using plastic sheeting.

h. Secure planned transport route by closing aircraft canopies and access doors and by installing aircraft inlets/exhaust covers. In addition, doors and windows of buildings along transportation route should be closed.

i. Tow wreckage carefully to prevent spreading CFs. Spray fixit on suspect areas of aircraft, soil, and hard surfaces to reduce CFs hazard.

3. GENERAL INFORMATION.

a. Lifting bags (air bags) must rest on clear surfaces free from debris and sharp or protruding objects.

b. Make sure aircraft has no projections or sharp edges in contact with air bags.

c. Use tarpaulin or canvas beneath air bags to prevent contact with ground.

d. Put felt pad on top of air bag to prevent contact with aircraft surfaces.

e. Use padding to fill irregular surfaces and provide protection from sharp edges on aircraft.

f. Support cribbing and sandbags are required for use under wings.

g. Do not support aircraft on air bags longer than required to lower landing gear or position jack.

h. Maximum air bag inflation pressure is 3.5 psi.

i. Air bag dimensions:

Deflated - 78 X 90 X 6 inches.

Inflated - 78 X 90 X 72 inches.

4. LIFTING CONFIGURATIONS AND METHODS OF POSITIONING AIR BAGS.

5. Lifting configurations were determined assuming all landing gear have collapsed. Use of air bags for other configurations may be adapted as required. Configurations and methods of positioning air bags are:

- a. Both wings spread.
- b. Outer wings folded or missing.
- c. One complete wing missing.
- d. Lifting forward fuselage to position air bag.
- e. Rolling tilted aircraft to upright position.
- f. Inflating air bags.

Support Equipment Required

Part Number or Type Designation	Nomenclature
F-2	Lifting Bag
MIL-W-4088	Nylon Strap 8 or 4 Inches Wide
—	Tarpaulin
—	Blower
—	Block and Tackle

Materials Required

Specification or Part Number	Nomenclature
—	Felt Pad, 1/2 Inch Thick
—	Wire Rope, 1/4
—	Wood Planks As Required
—	Wood Beam, 6 X 6 X 168 Inches

6. BOTH WINGS SPREAD. See figure 1.

- a. Moor aircraft (WP010 02).
- b. Position nose air bag.

NOTE

Digging under fuselage may be required to gain clearance.

- (1) Clear area under nose section.
- (2) Position tarpaulin forward of NLG doors at Y204.00.
- (3) Position aft end of air bag directly forward of NLG doors, on tarpaulin, at Y204.00.

(4) Center air bag and make sure longest dimension is fore and aft.

(5) Position felt pad on air bag.

- c. Position wing air bags, two required.

NOTE

Make sure sandbag part of support cribbing conforms, as close as possible, to air bag 78 X 90 inch dimensions.

- (1) Construct 24 inch high support cribbing, see figure 2.

NOTE

When positioning support cribbing, make sure enough clearance is provided for leg spread of tripod jacks.

(2) Position inboard edge of support cribbing far enough outboard of wing tie down and jacking point to avoid interference with tripod jack leg spread. Align front edge of support cribbing at intersection of forward spar and leading edge flaps.

(3) Position tarpaulin on sandbag part of support cribbing.

(4) Center air bag on sandbag part of support cribbing, longest dimension spanwise.

(5) Position felt pad on air bags.

(6) Inflate air bags, paragraph 10.

7. OUTER WINGS FOLDED OR MISSING. See figure 1.

- a. Moor aircraft (WP010 02).
- b. Position center fuselage air bag.

NOTE

Digging under center fuselage may be required to gain clearance.

- (1) Clear area under center fuselage. Make sure cleared area is far enough aft of Y338.00 to allow for leg spread of tripod jack.
- (2) Position tarpaulin on clear area.

(3) Center air bag on tarpaulin with longest dimension fore and aft. Make sure forward edge of air bag is far enough aft of Y338.000 to allow for leg spread of tripod jack.

(4) Position felt pad on air bag.

c. Position aft fuselage air bag.



To prevent additional structure damage, do not position air bag aft of arresting hook pivot fittings.

NOTE

Digging under aft fuselage may be required to gain clearance.

(1) Clear area under aft fuselage directly forward of arresting hook pivot fitting.

(2) Position tarpaulin on cleared area.

(3) Center air bag on tarpaulin with longest dimension fore and aft. Make sure aft edge of air bag is directly forward of arresting hook pivot fitting.

(4) Position felt pad on air bag.

d. Position wing air bags, two required.

NOTE

Make sure sandbag part of support cribbing conforms, as close as possible, to air bag 78 X 90 inch dimensions.

(1) Construct 24 inch high support cribbing, see figure 2.

(2) Position support cribbing directly forward of jack point at Y508.00 with longest dimension spanwise. Leave enough room to allow for leg spread of tripod jack(s). Keep outer edge of support cribbing approximately 1 foot inboard of wing fold.

(3) Position tarpaulin on sandbag part of support cribbing.

(4) Center air bag on sandbag part of support cribbing with longest dimension spanwise.

(5) Position felt pad on air bag.

(6) Inflate air bags, paragraph 10.

8. **ONE COMPLETE WING MISSING.** See figure 1.

a. Moor aircraft (WP010 02).

b. Position nose air bag.

NOTE

Digging under fuselage may be required to gain clearance.

(1) Clear area under nose section.

(2) Position tarpaulin forward of nose landing gear doors at Y204.00.

(3) Position aft end of air bag directly forward of NLG doors, on the tarpaulin, at Y204.00.

(4) Center air bag and make sure longest dimension is in fore and aft direction.

(5) Position felt pad on air bag.

c. Position center fuselage air bag.

NOTE

Digging under center fuselage may be required to gain clearance.

(1) Clear area under center fuselage. Make sure cleared area is far enough aft of Y388.00 to allow for leg spread of tripod jacks.

(2) Position tarpaulin on cleared area.

(3) Center air bag on tarpaulin with longest dimension fore and aft. Make sure forward edge of air bag is far enough aft of Y338.00 to allow for leg spread of tripod jack.

(4) Position felt pad on air bag.

d. Position aft fuselage air bag.



To prevent additional structure damage, do not position air bag aft of arresting hook pivot fitting.

NOTE

Digging under aft fuselage may be required to gain clearance.

(1) Clear area under aft fuselage forward of arresting hook pivot fitting.

(2) Position tarpaulin on cleared area.

(3) Center air bag on tarpaulin with longest dimension fore and aft. Make sure aft edge of air bag is directly forward of arresting hook pivot fitting.

(4) Position felt pad on air bag.

e. Position wing air bag.

(1) Clear area under wing.

(2) Position tarpaulin.

(3) Position air bag close as possible to wing tip without digging.

(4) Make sure air bag is positioned with longest dimension in spanwise direction.

(5) Position felt pad on air bag.

(6) Inflate air bags, paragraph 10.

9. LIFTING FORWARD FUSELAGE TO POSITION AIR BAG. If digging is not possible, forward fuselage may require raising to enable maintenance personnel to position an air bag. Forward fuselage may be raised by either method listed below:

a. Lift with jacks and nylon strap. See figure 3.

(1) Moor aircraft (WP010 02).

NOTE

Make sure enough space is allowed between jacks to position air bag. Wood planks may be required to support jacks on soft surfaces.

(2) Position one jack on each side of forward fuselage at Y128.400.

(3) Position wood beam on jacks over forward fuselage.

(4) Position nylon strap on wood beam and center strap on Y128.5, radome attachment frame.



Make sure jacks and nylon strap(s) are vertically aligned so jacks will not tip while going up.

(5) Raise both jacks slowly to tighten strap(s), but keep strap(s) loose enough to make final adjustment of strap(s) and jacks before raising forward fuselage.

NOTE

Make sure enough clearance is allowed for NLG doors.

(6) Raise jacks slowly until forward fuselage is approximately 8 inches off surface.

(7) Clear area under forward fuselage, forward of NLG doors.

(8) Position tarpaulin forward of NLG doors at Y204.00.

(9) Position aft end of air bag directly forward of NLG doors, on tarpaulin, at Y204.00.

(10) Center air bag and make sure longest dimension is fore and aft.

(11) Position felt pad on air bag.

(12) Lower forward fuselage onto air bag by slowly lowering jacks.

(13) Remove jacks and wood beam; nylon straps may not be free to remove.

(14) Inflate air bags, paragraph 10.

b. Lift with forklift and nylon strap. See figure 4.

(1) Moor aircraft (WP010 02).

(2) Remove radome (A1-F18AC-SRM-220, WP003 03 or A1-F18AE-SRM-650, WP006 00).

(3) Position forklift directly forward of aircraft with forks extended over top of fuselage.

NOTE

Two 4 inch nylon straps may be used if an 8 inch nylon strap is not available.

(4) Position nylon strap on forklift and center strap on Y139.7. If two 4 inch nylon straps are used, position straps on forklift and center straps on Y139.7 and Y152.25, see figure 4.

(5) Secure nylon strap(s) to forklift per figure 4.

(6) Raise forward fuselage approximately 8 inches off the surface.

NOTE

When positioning air bag, make sure enough clearance is allowed for NLG doors.

(7) Clear area under forward fuselage, forward of NLG doors.

(8) Position tarpaulin forward of NLG doors at Y204.00.

(9) Position aft end of air bag directly forward of NLG doors, on tarpaulin, at Y204.00.

(10) Center air bag and make sure longest dimension is fore and aft.

(11) Position felt pad on air bag.

(12) Lower forward fuselage onto air bag by slowly lowering jacks.

(13) Remove forklift from forward fuselage area. Nylon strap(s) may not be free to remove.

(14) Inflate air bag, paragraph 10.

10. ROLLING TILTED AIRCRAFT TO UPRIGHT POSITION. See figure 5.

a. Aircraft with wings spread.

(1) Clear area under wing tip area on tilted side of aircraft.

(2) Position tarpaulin on cleared area.

(3) Without digging, position air bag on tarpaulin close as possible to wing tip. Position forward edge of air bag close as possible to leading edge.

(4) Position felt pad on air bag.

(5) If NLG is also collapsed, position air bag per paragraph 5.

(6) Connect mooring lines, if not already connected and man each line (WP010 02).

(7) Connect blower to air bag(s).

NOTE

Inflate air bag(s) just enough to lower landing gear or position jack.

(8) Inflate air bag to maximum of 3.5 psi pressure.

(9) Lower landing gear or position jack.

b. Outer wing folded or missing.

NOTE

Make sure 14 inches minimum clearance is provided for wing jack.

(1) Clear area under wing on tilted side of aircraft.

(2) Position tarpaulin close as possible to wing fold.

(3) Position air bag on tarpaulin, close as possible to wing fold with forward edge of air bag at wing leading edge.

(4) Position felt pad on air bag.

(5) If NLG is also collapsed, position air bag per paragraph 5.

(6) Connect mooring lines if not already connected and man each line (WP010 02).

(7) Connect blower to air bag(s).

NOTE

Inflate air bag(s) just enough to lower landing gear or position jack(s).

(8) Inflate air bag(s) to maximum 3.5 psi pressure.

(9) Lower landing gear or position jack(s).

11. INFLATING AIR BAGS. Air bags are inflated as listed below:

a. Both wings spread or outer wings folded or missing configurations, see figures 1 and 6.

(1) Connect all air bags to one blower.

(2) Connect mooring lines if not already connected and man each line (WP010 02).

(3) Slowly inflate air bags, simultaneously, adjusting, letting out, mooring lines as required.

NOTE

Air bags do not have good air retention, use only as long as required.

(4) Inflate air bags only as high as required to lower landing gear or position jacks.

b. One complete wing missing configuration, see figures 1 and 6.

(1) Connect fuselage air bags to one blower.

(2) Connect wing bag to separate blower.

(3) Connect mooring lines if not already connected and man each line (WP010 02).

(4) Slowly inflate fuselage air bags, simultaneously, adjusting, letting out mooring lines as required.

WARNING

Do not roll aircraft to level position before doing this lift. If aircraft is raised to level position, it may roll to its side injuring personnel or damaging aircraft.

NOTE

Air bags do not have good air retention, use only as long as required.

(5) Inflate wing air bag as required, while keeping wing tilted slightly lower than fuselage. Raise aircraft only high enough to lower landing gear or install jacks.

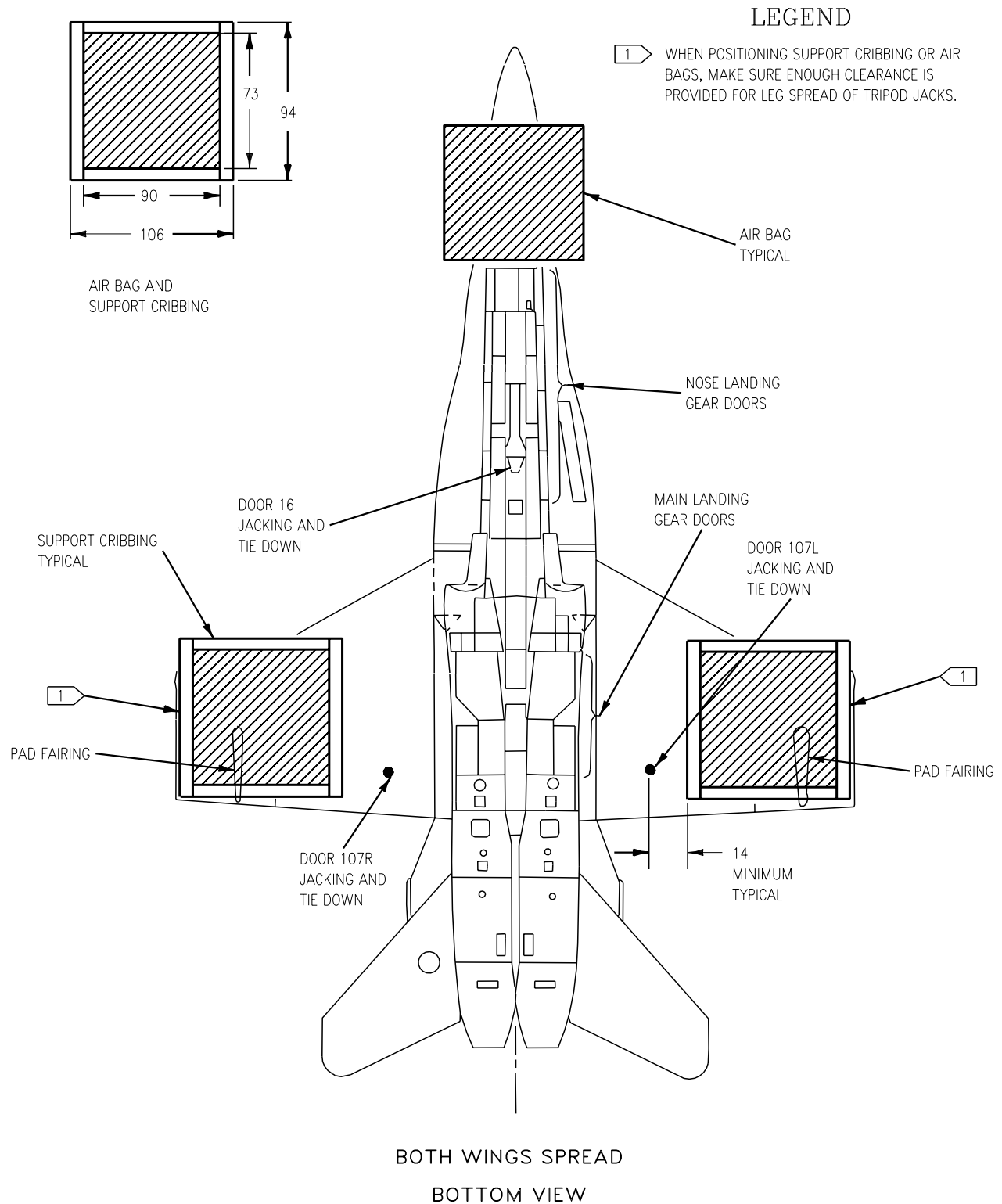


Figure 1. Lifting Aircraft With Air Bags (Sheet 1)

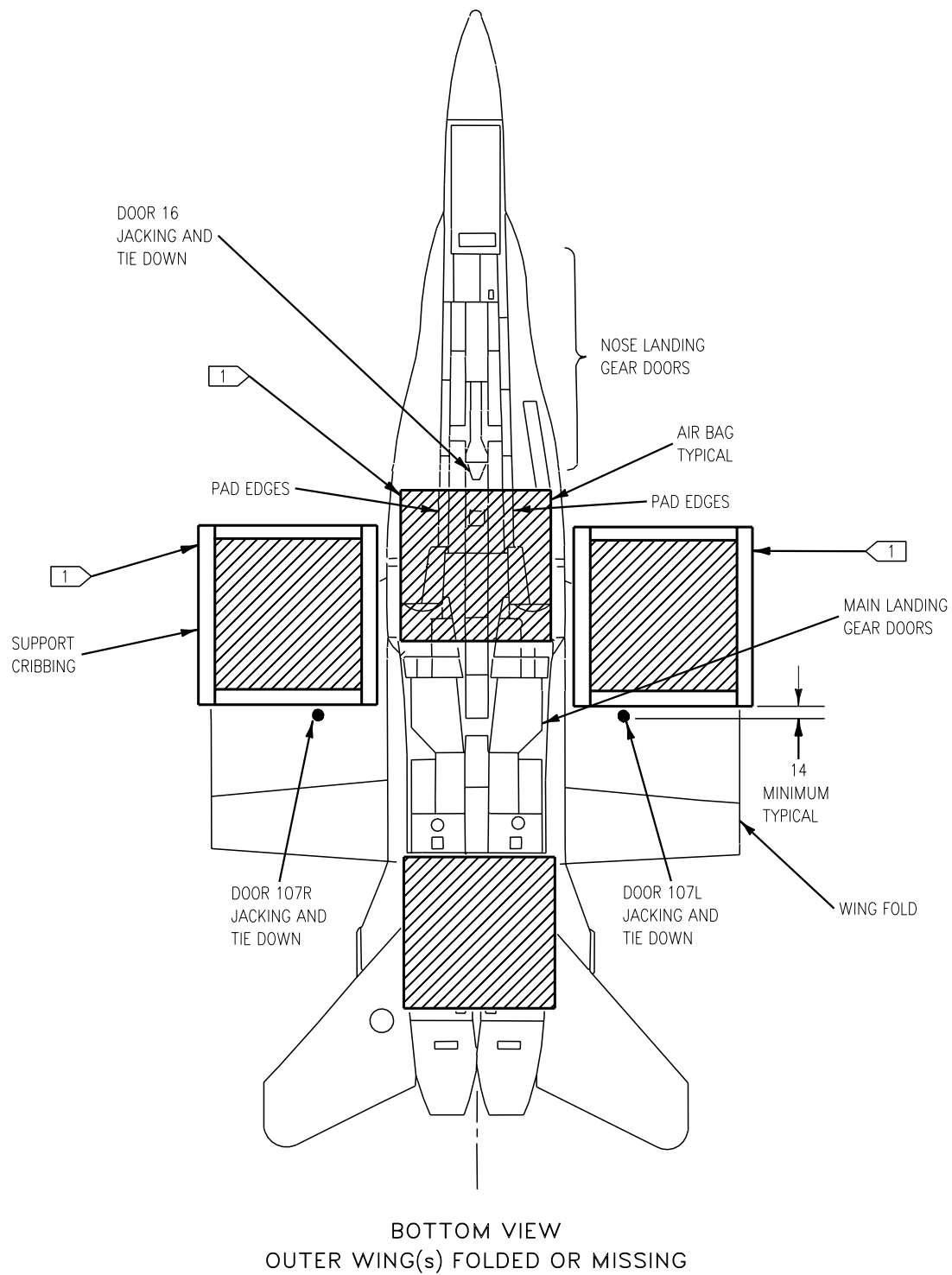


Figure 1. Lifting Aircraft With Air Bags (Sheet 2)

WARNING

LIFT AIRCRAFT SLOWLY KEEPING WING TILTED BELOW FUSELAGE. IF AIRCRAFT IS RAISED TO LEVEL POSITION, IT MAY ROLL TO ITS SIDE INJURING PERSONNEL OR DAMAGING AIRCRAFT.

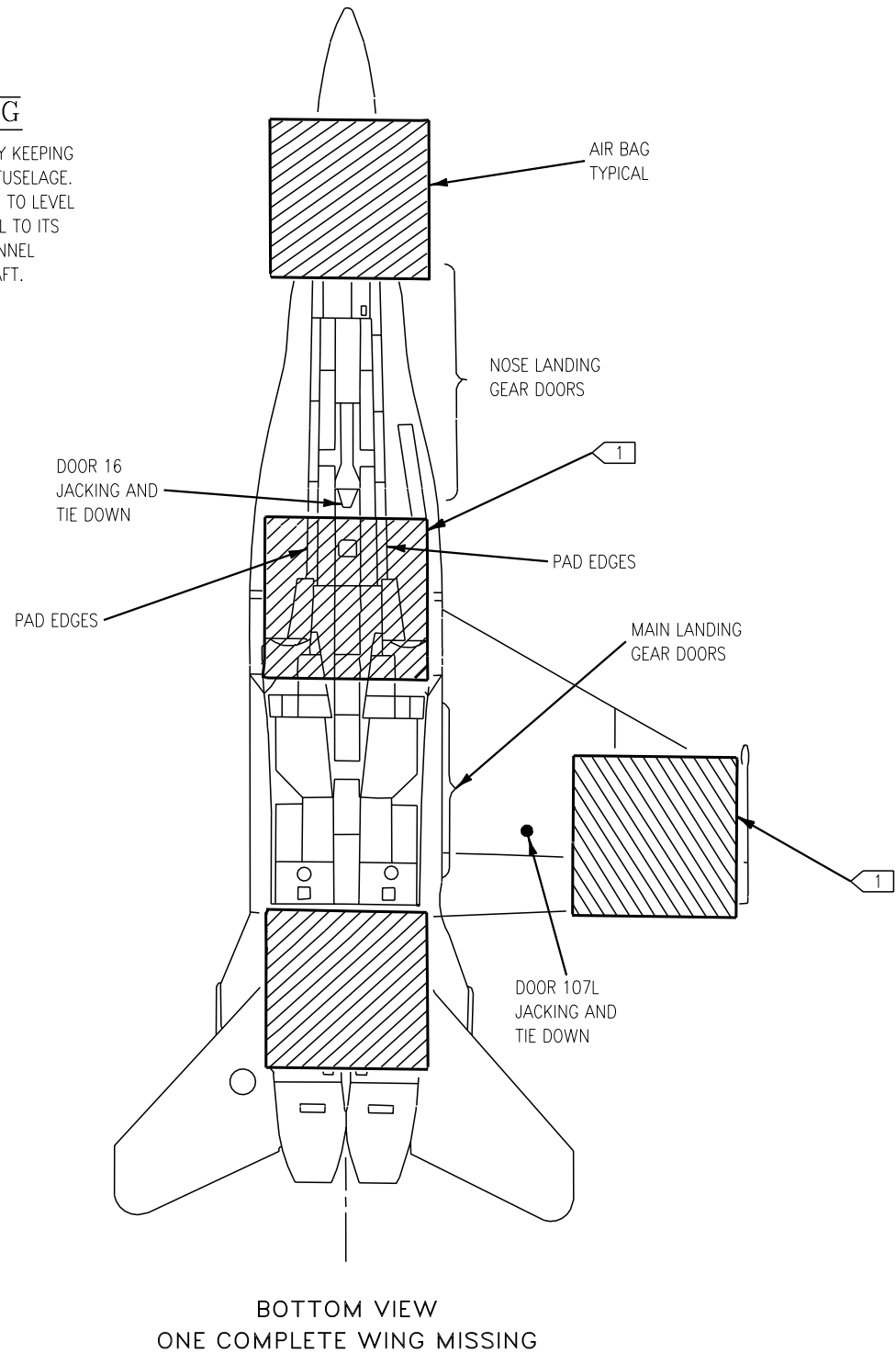


Figure 1. Lifting Aircraft With Air Bags (Sheet 3)

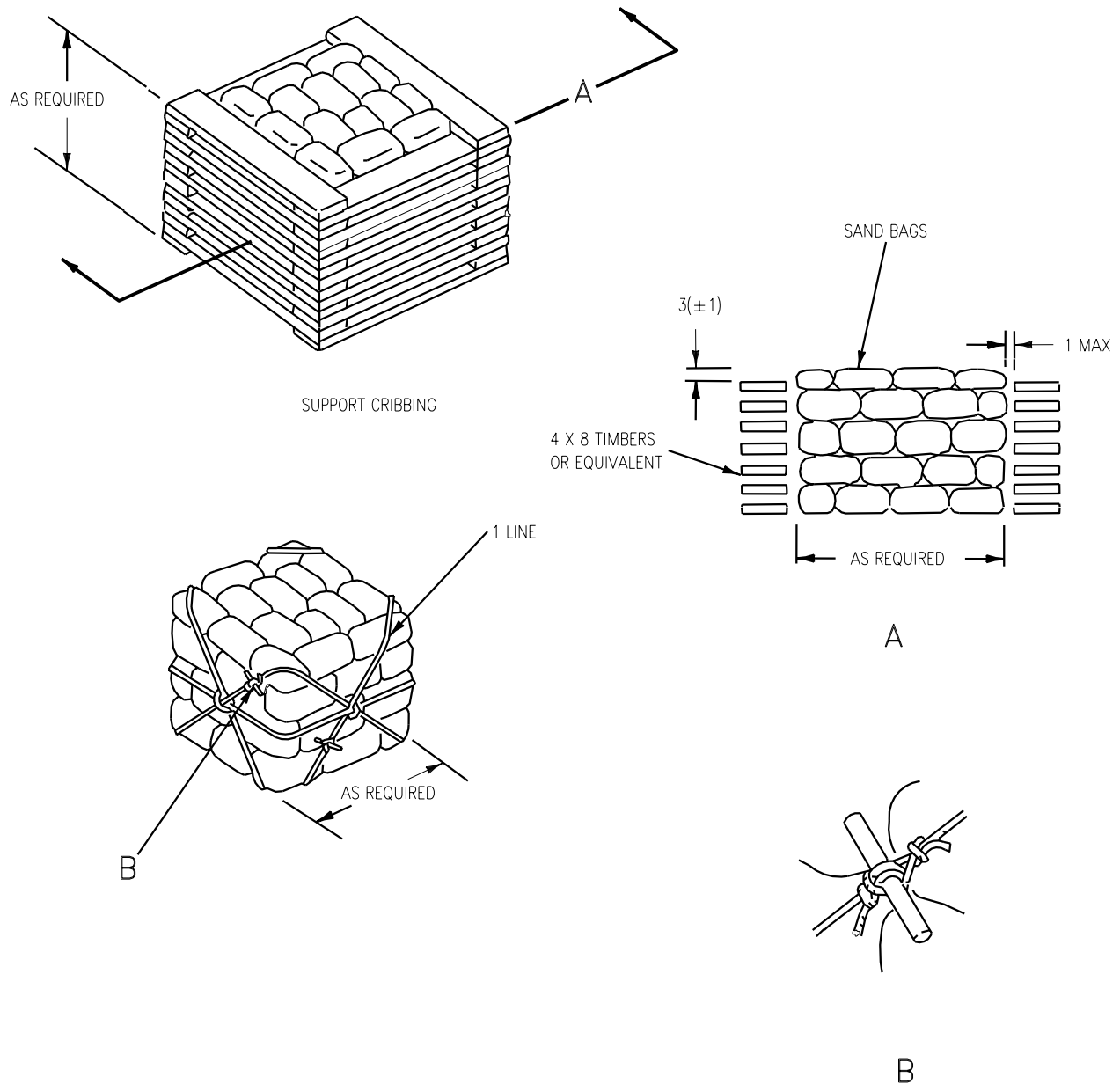


Figure 2. Cribbing Used With Air Bags

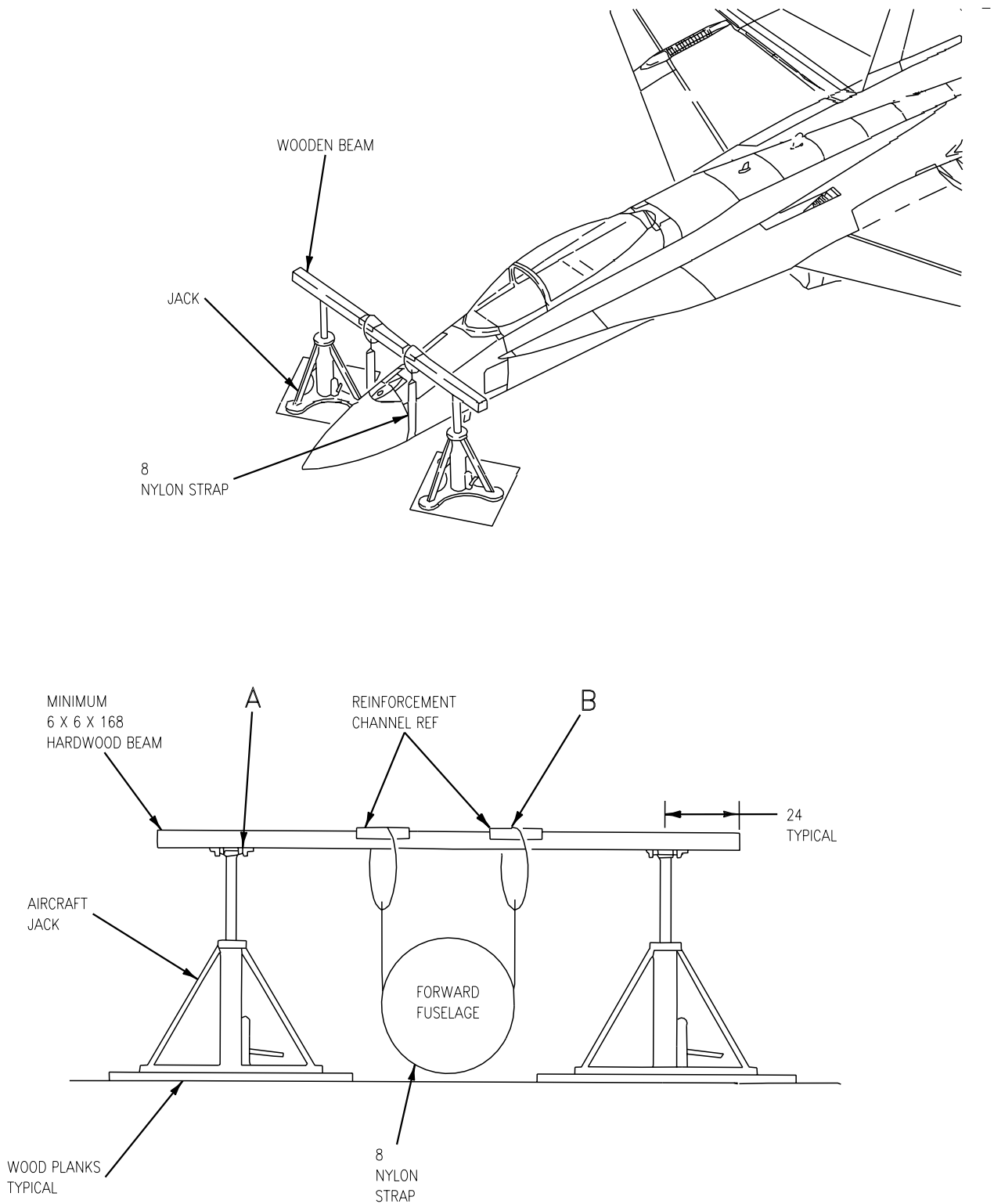


Figure 3. Lifting Aircraft With Jacks and Nylon Strap to Position Air Bag (Sheet 1)

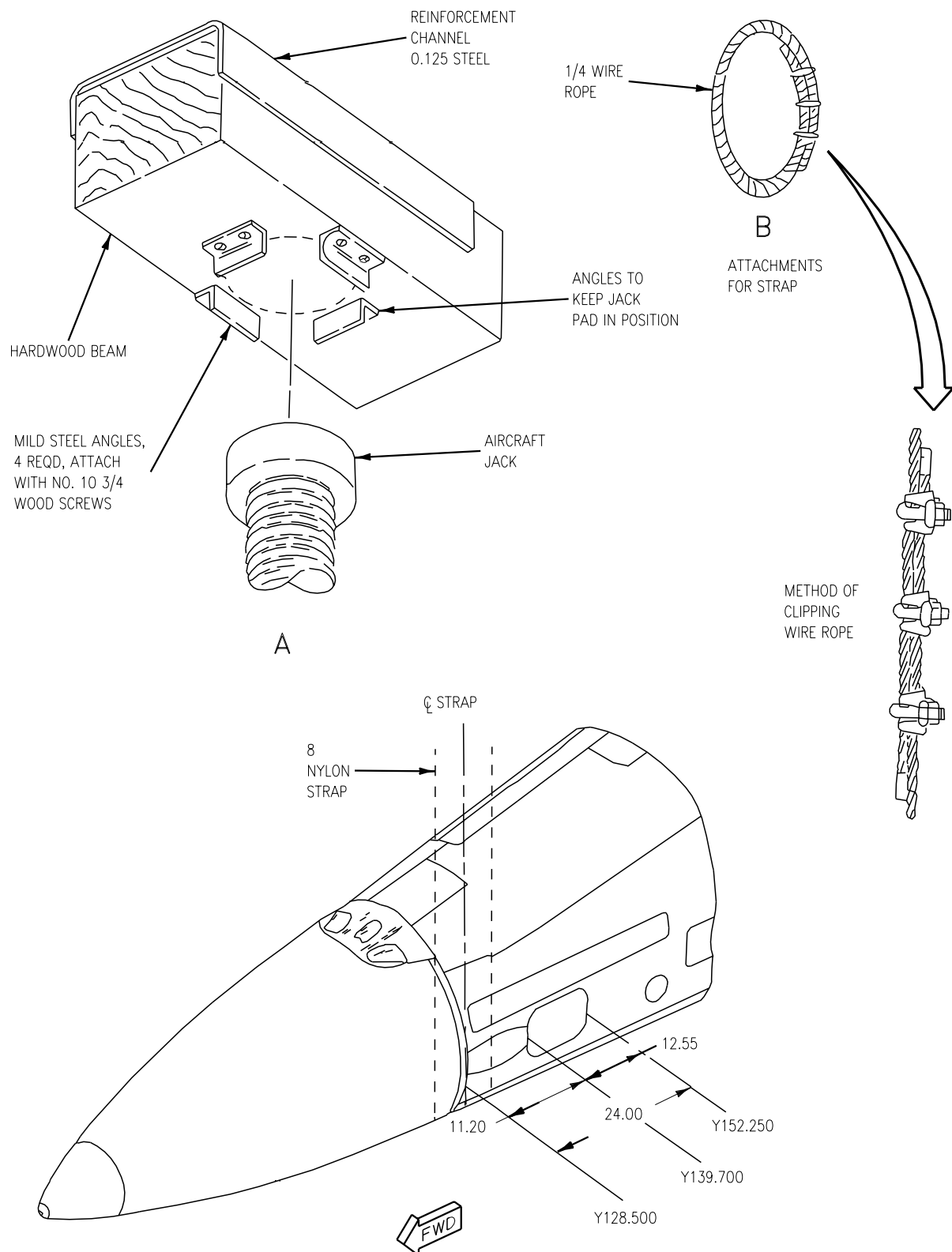


Figure 3. Lifting Aircraft With Jacks and Nylon Strap to Position Air Bag (Sheet 2)

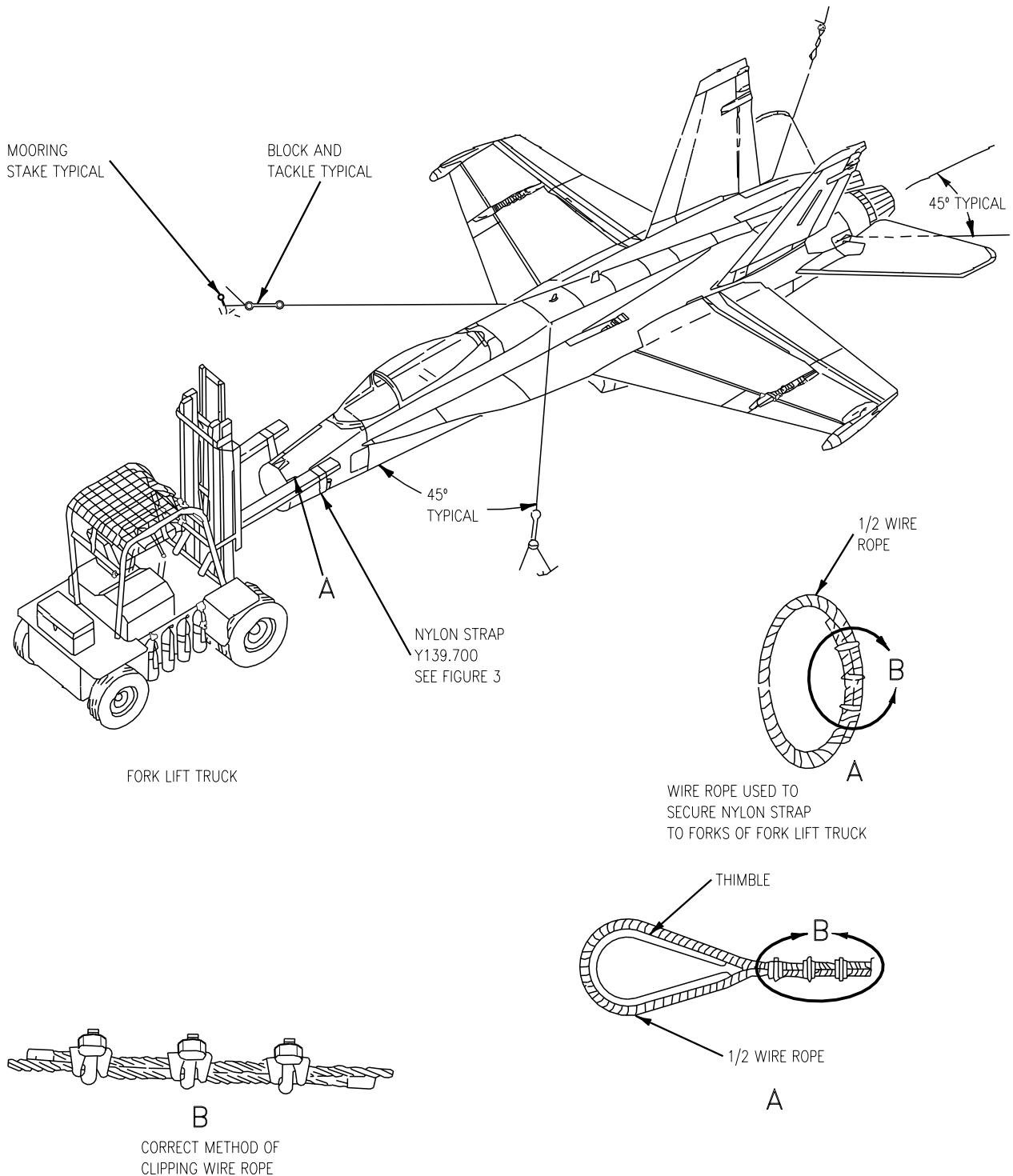


Figure 4. Lifting Aircraft With Forklift Truck and Nylon Strap(s) to Position Air Bag

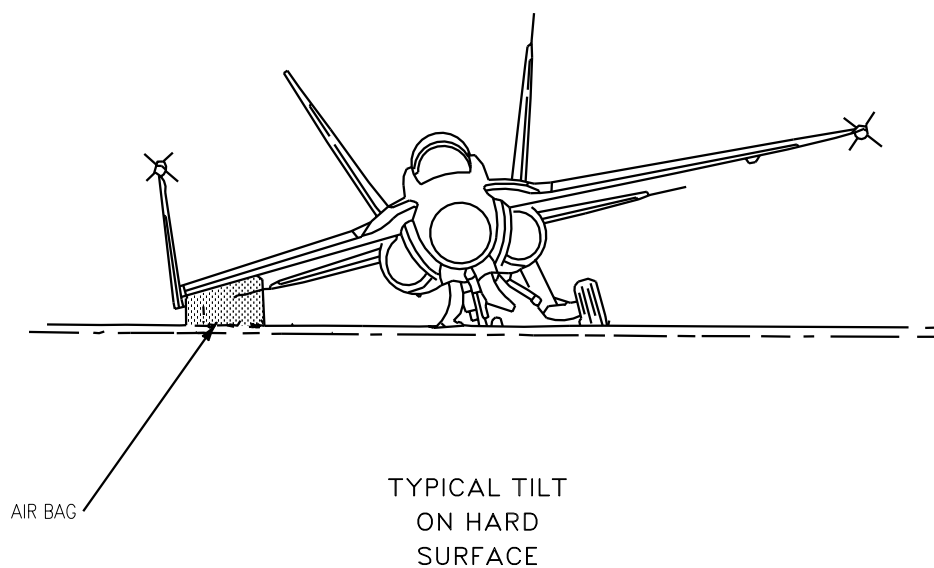
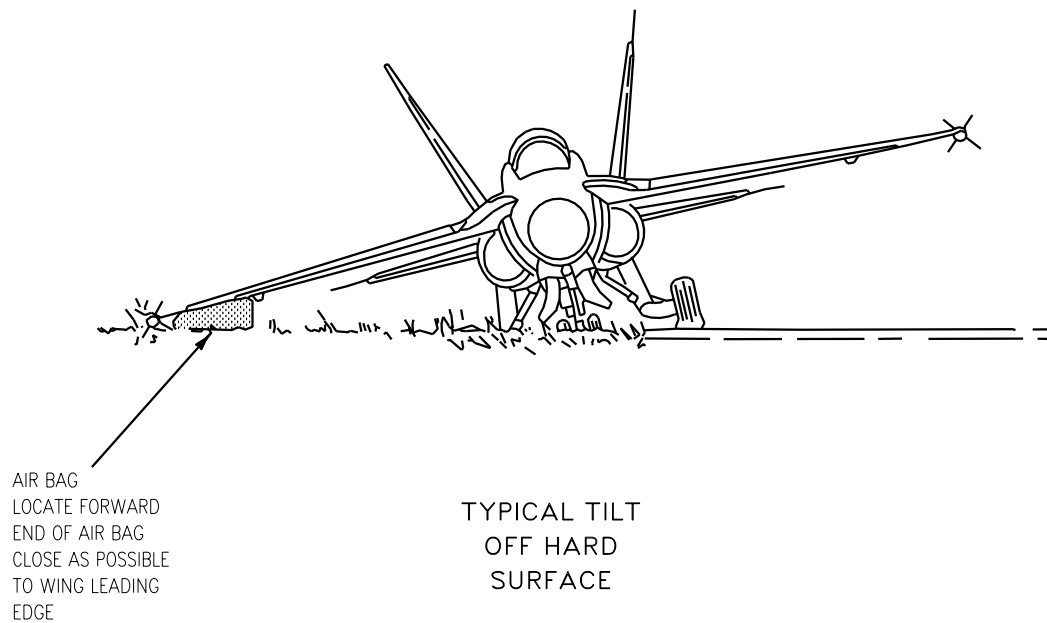


Figure 5. Rolling Tilted Aircraft to Upright Position

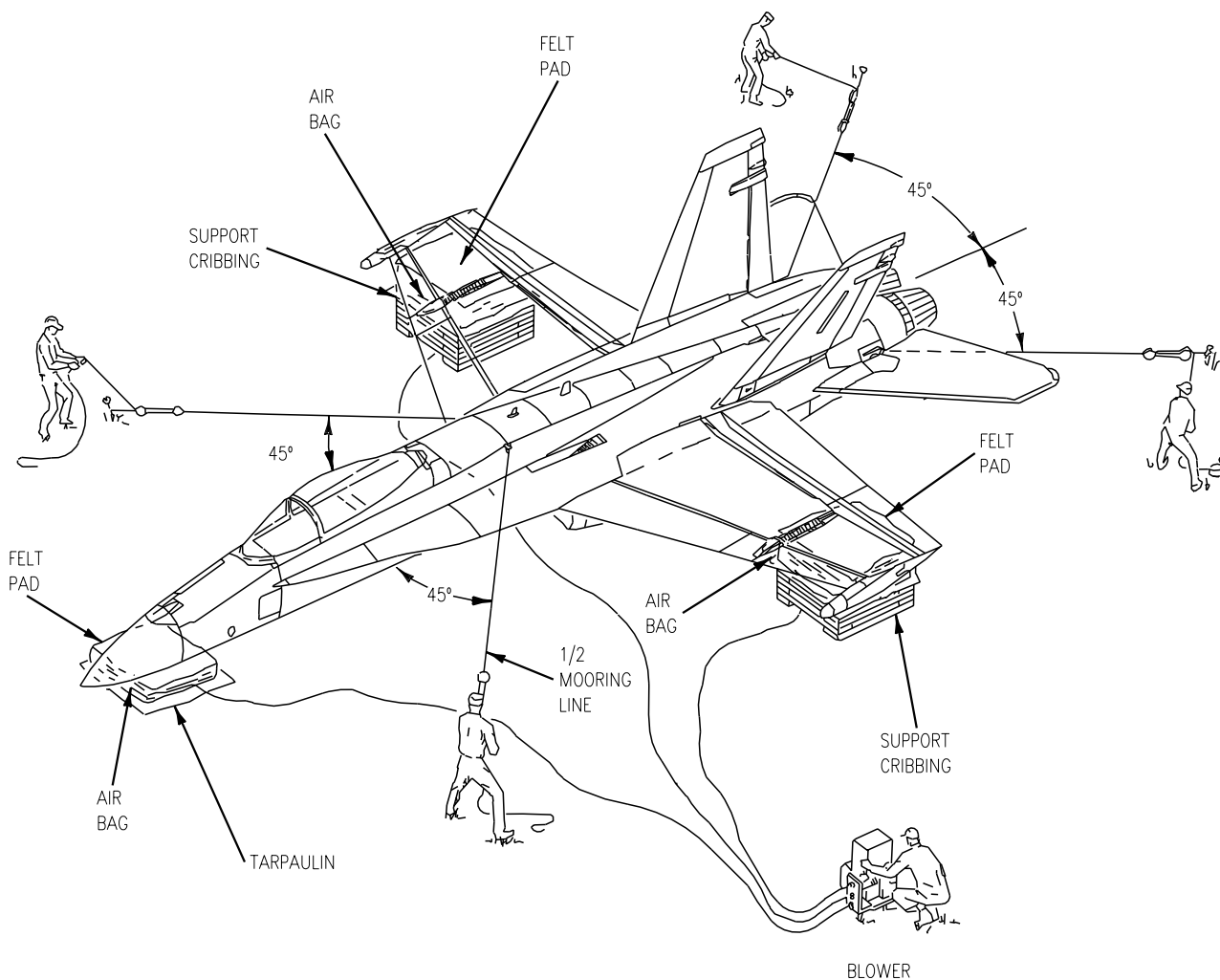


Figure 6. Inflating Air Bags (Sheet 1)

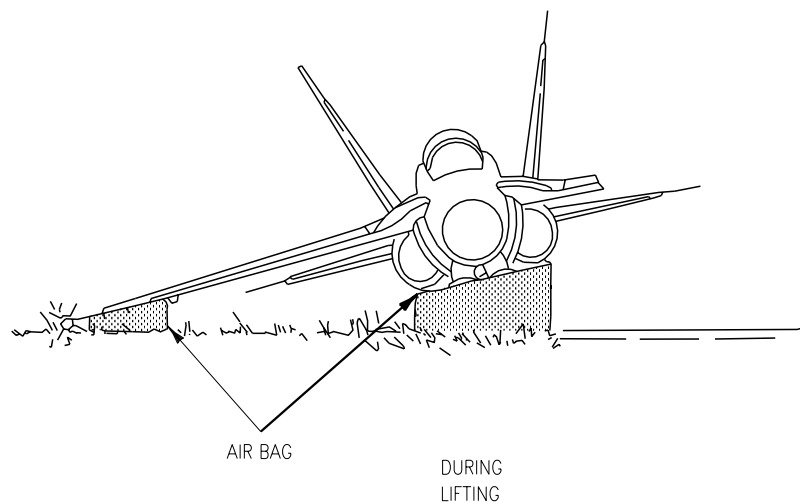
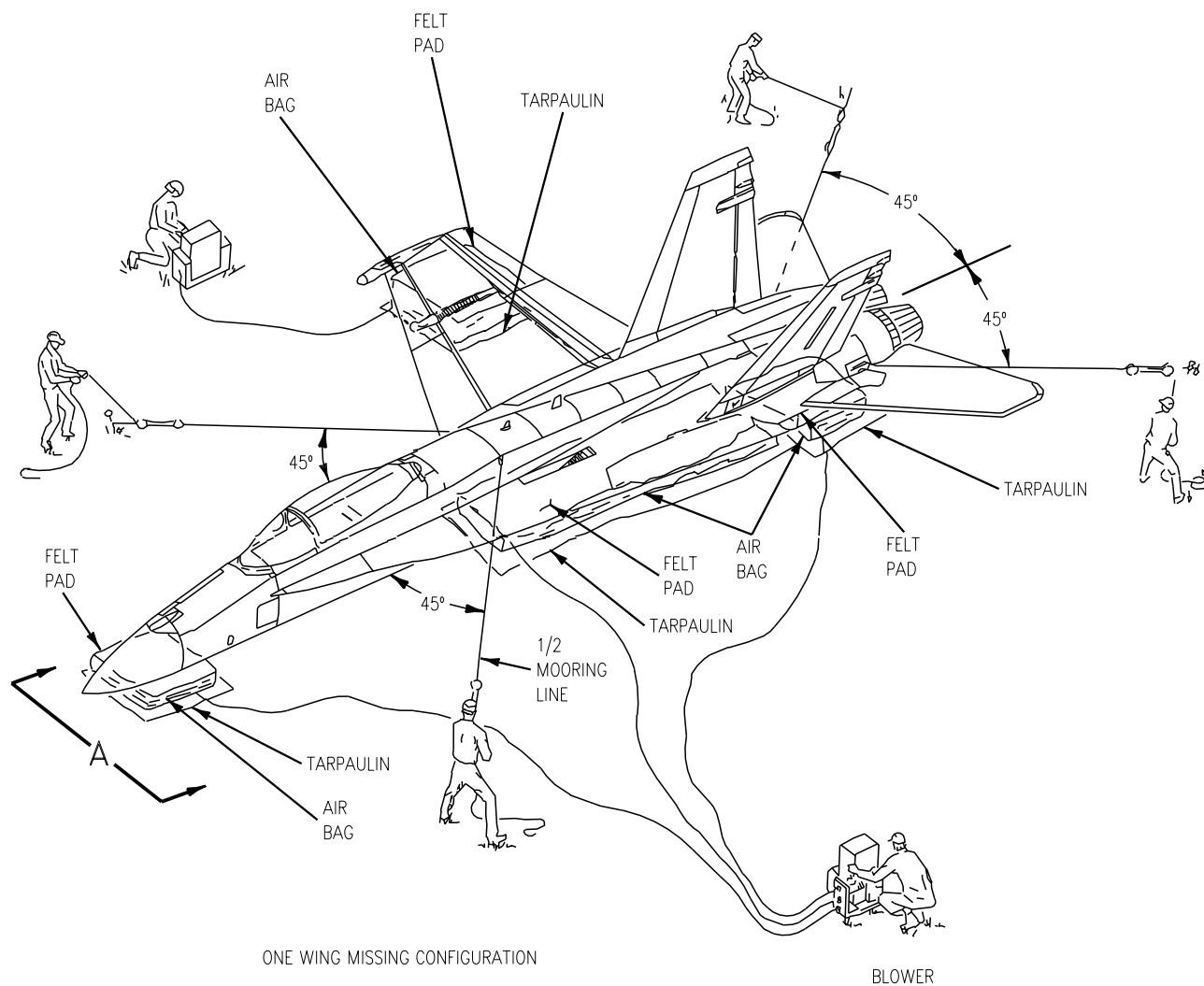


Figure 6. Inflating Air Bags (Sheet 2)

ORGANIZATIONAL MAINTENANCE

STRUCTURE REPAIR

CRASH HANDLING

HOISTING AND MOORING AIRCRAFT

Reference Material

Structural Hardware.....	NAVAIR 01-1A-8
Line Maintenance Procedures.....	A1-F18AC-LMM-000

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Mooring Aircraft.....	2
Safety Precautions For Carbon Epoxy Fibers	1

Record of Applicable Technical Directives

None

1. SAFETY PRECAUTIONS FOR CARBON EPOXY FIBERS.

a. Close all windows, doors, ventilation openings, and other access to outside when carbon epoxy fibers (CFs) accidents occur in or around shop/hanger area.

b. Turn off non-essential electrical equipment until cleanup is completed.

c. Restrict passage of personnel into and out of areas containing electric equipment for duration of cleanup.

d. CFs act as irritants similar to fiberglass, when present in moderate to heavy amounts:

(1) Personnel should be provided dust masks, gloves, and eye protection.

(2) Eating, drinking, and smoking should be prohibited.

e. CFs have low electrical resistance values and are influenced by high voltage circuits.

f. Vacuum bags and filters, effluent filters, contaminated equipment filters, and collected CFs/residue shall be placed in plastic bags, sealed, and disposed of by burial. Bags should be marked 'carbon fiber debris, do not incinerate, do not sell for scrap, dispose of in landfill only. At sea, bags shall be retained for shore disposal.

g. Before moving wreckage/debris, immobilize loose/exposed CFs using plastic sheeting.

h. Secure planned transport route by closing aircraft canopies and access doors and by installing aircraft inlets/exhaust covers. In addition, doors and windows of buildings along transportation route should be closed.

i. Tow wreckage carefully to prevent spreading CFs. Spray fixit on suspect areas of aircraft, soil, and hard surfaces to reduce CFs hazard.

2. PROCEDURES.

Support Equipment Required

Part Number or Type Designation	Nomenclature
—	Block and Tackle

Materials Required

Specification or Part Number	Nomenclature
—	Felt Padding, 1/2 Inch
MIL-W-83420	Flexible Cable, Wire Rope, 7 X 7
AN48-22	Eyebolt
T-R-605, TYPE M, CLASS 1	Manila Rope, 1/2 Inch

WARNING

Maximum hoist weight is 40,600 pounds.

Mooring lines must be connected when
hoisting aircraft.

3. **HOISTING.** Hoist the aircraft
(A1-F18AC-LMM-000).

4. **MOORING AIRCRAFT.** Aircraft should be
securely moored as soon as practical. If aircraft
crash landed, wheels up, it may be moored using
forward and aft mooring lines shown in figure 1.
Block and tackle should be used on all lines, this
allows adjusting (letting out) lines while aircraft is
being lifted.

a. Use block and tackle with 1/2 inch manila
rope.

b. At forward hoist point use AN48-22 eyebolts,
reamed to head hole size of 1/2 to receive 1/2 inch
manila rope or splice 7 X 7 flexible cable, making a
loop to go through eyebolt, see figure 1. Splicing
flexible cable (NAVAIR 01-1A-8).

c. All lifting configurations shall be moored
using instructions contained in this work package.

d. Pad lower aft corner of door 73 to prevent
cutting manila rope.

e. Orient lines at 45° to aircraft center lines
and inspect to make sure lines do not get twisted or
kinked at hoist fitting. Do not leave mooring lines
unattended.

f. Wrap manila rope twice around spindle
support bracket and then tie rope securely.

g. If stakes can not be used to assist mooring
operation, use four trucks.

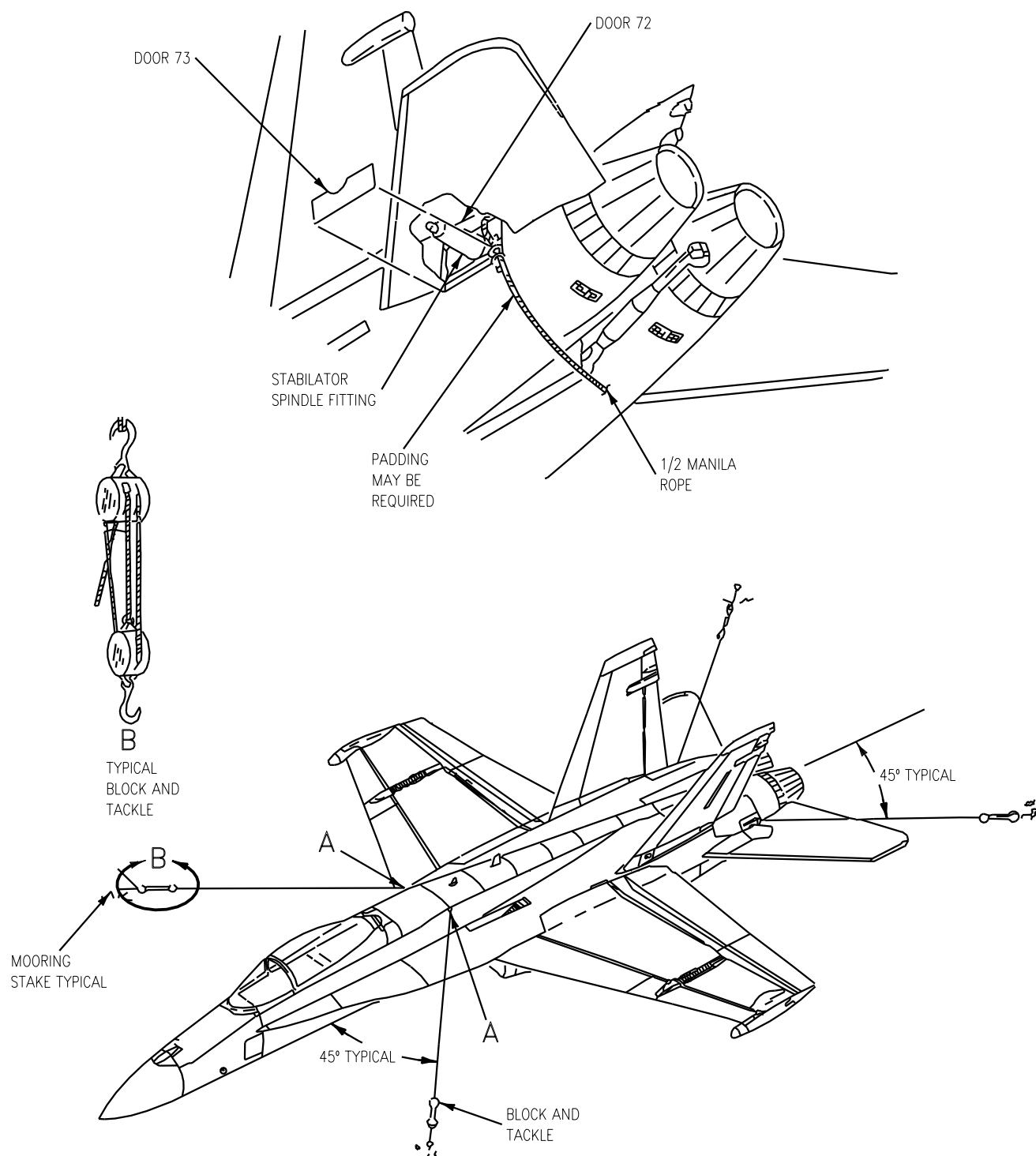


Figure 1. Mooring Aircraft (Sheet 1)

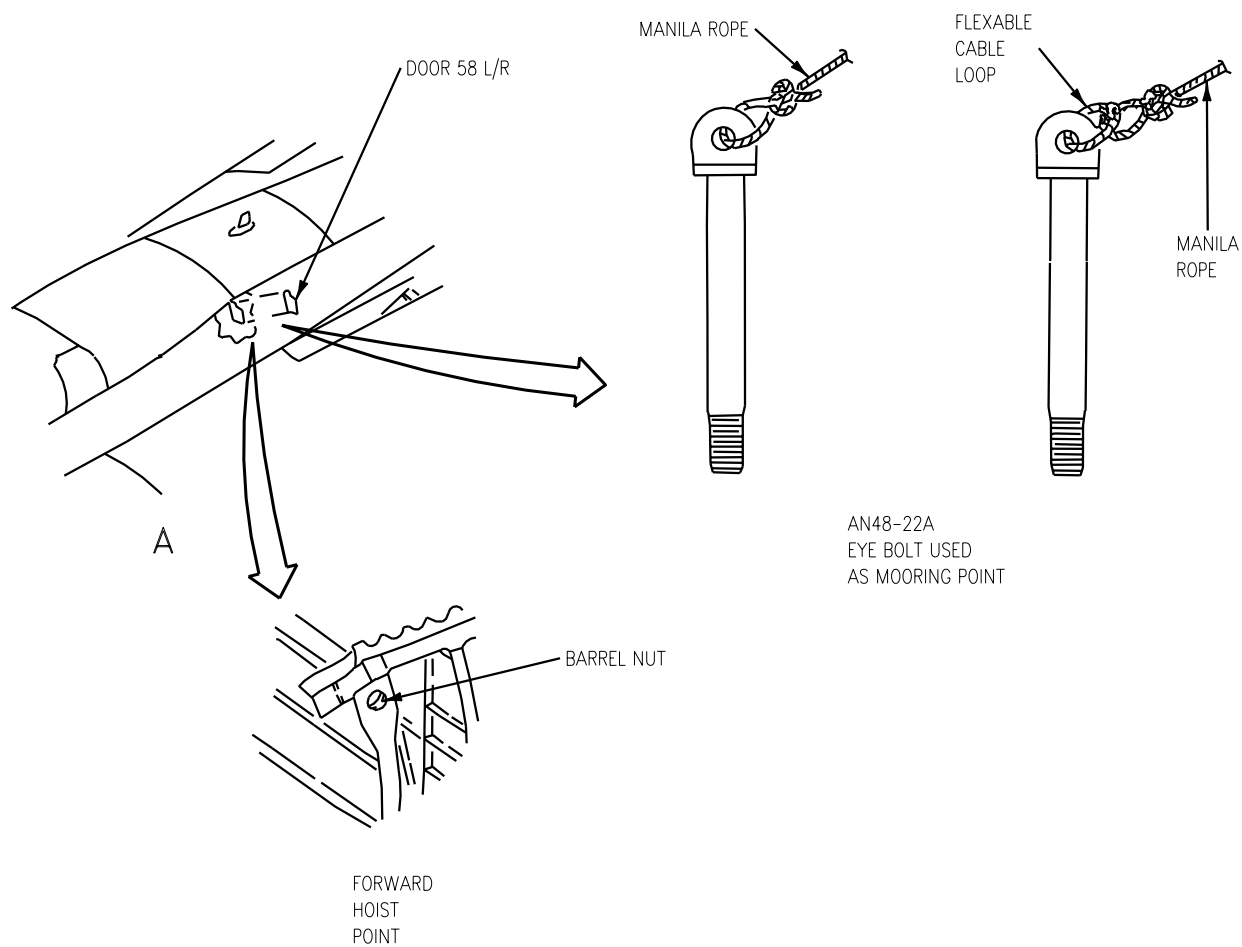


Figure 1. Mooring Aircraft (Sheet 2)

ORGANIZATIONAL, INTERMEDIATE, AND DEPOT MAINTENANCE**STRUCTURE REPAIR****CRASH HANDLING****MOVING CRASH DAMAGED AIRCRAFT USING TRACTOR TRAILER, FLAT BED TRAILER**

Reference Material

Structure Repair, Aft Fuselage	A1-F18AE-SRM-750
Vertical Stabilizer Removal and Installation Maintenance Fixtures RE274000010-1, Holding Fixture RE174000010-1 and Hoisting Adapter 74D110135	WP048 00
Structure Repair, Aft Fuselage	A1-F18AC-SRM-240
Vertical Stabilizer Removal and Installation Maintenance Fixtures RE274000010-1, Holding Fixture RE174000010-1, and Hoisting Adapter 74D110135	WP026 01
Structure Repair, Wing	A1-F18AE-SRM-600
Outer Wing Removal Installation	WP037 00
Inner Wing Removal and Installation	WP047 00
Structure Repair, Wing	A1-F18AC-SRM-210
Inner Wing Removal and Installation	WP025 00
Outer Wing Removal and Installation	WP020 00
Line Maintenance Procedures	A1-F18AC-LMM-000
Structure Repair, General Information	A1-F18AC-SRM-200
Hoisting and Mooring Aircraft	WP010 02
Plane Captain Manual	A1-F18AC-PCM-000
Structure Repair, Forward Fuselage	A1-F18AE-SRM-650
Radome Replacement Effectivity 163427 THRU 163782	WP006 00
Radome Replacement Effectivity 163985 AND UP	WP006 01
Structure Repair, Forward Fuselage	A1-F18AC-SRM-220
Radome Replacement	WP003 03
Integrated Flight Controls	A1-F18AC-570-300
Stabilator (84MPS529 or 84MPT530)	WP021 00

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Remove Outer Wings.....	3
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Record of Applicable Technical Directives

None

1. NO LANDING GEAR CONFIGURATION.

See figure 1.

2. In the no landing gear configuration; landing gear is either sheared or inoperative in the up position.

3. SAFETY PRECAUTIONS.

Every attempt must be made to keep crash damaged aircraft from additional damage.

a. Make sure battery switch is in OFF position (A1-F18AC-LMM-000).

b. Install ground safety devices required during all ground operations or maintenance (A1-F18AC-PCM-000).

c. Defuel aircraft (A1-F18AC-PCM-000).

d. Remove liquid oxygen converter (A1-F18AC-LMM-000).

4. SAFETY PRECAUTIONS FOR CARBON EPOXY FIBERS.

a. Close all windows, doors, ventilation openings, and other access to outside when carbon epoxy fibers (CFs) accidents occur in or around shop/hanger area.

b. Turn off non-essential electrical equipment until cleanup is completed.

c. Restrict passage of personnel into and out of areas containing electric equipment for duration of cleanup.

d. CFs act as irritants similar to fiberglass, when present in moderate to heavy amounts:

(1) Personnel should be provided dust masks, gloves, and eye protection.

(2) Eating, drinking, and smoking should be prohibited.

e. CFs have low electrical resistance values and are influenced by high voltage circuits.

f. Vacuum bags and filters, effluent filters, contaminated equipment filters, and collected CFs/residue shall be placed in plastic bags, sealed, and disposed of by burial. Bags should be marked 'carbon fiber debris, do not incinerate, do not sell for scrap, dispose of in landfill only. At sea, bags shall be retained for shore disposal.

g. Before moving wreckage/debris, immobilize loose/exposed CFs using plastic sheeting.

h. Secure planned transport route by closing aircraft canopies and access doors and by installing aircraft inlets/exhaust covers. In addition, doors and windows of buildings along transportation route should be closed.

i. Tow wreckage carefully to prevent spreading CFs. Spray fixit on suspect areas of aircraft, soil, and hard surfaces to reduce CFs hazard.

5. **PROCEDURES.** Assemblies removed as required.

Support Equipment Required

Part Number or Type Designation	Nomenclature
74D110003-1001	Aircraft Maintenance Sling
MB-1A or Equivalent	Mobile Crane Truck- Ashore

Materials Required

Specification or Part Number	Nomenclature
—	Felt Pad, 1/2 Inch Thick
—	Rubber Padding
—	Wood, 4X4, 6 Feet Long, A/R
—	Fasteners, A/R
T-R-605TYPEM, CLASS2, SIZE1-1/2 IN	Rope Fibrous, Manila Rope

6. **Remove Vertical Stabilizers.** Depot maintenance, (A1-F18AE-SRM-750, WP048 00 or A1-F18AC-SRM-240, WP026 01).

7. **Remove Outer Wings.** Depot maintenance, (A1-F18AE-SRM-600, WP037 00 or A1-F18AC-SRM-210, WP020 00).

8. **Remove Inner Wings.** Depot maintenance, (A1-F18AE-SRM-600, WP047 00 or A1-F18AC-SRM-210, WP025 00).

9. **Remove Nose Radome.** Organizational maintenance, (A1-F18AE-SRM-650, WP006 00 and WP006 01 or A1-F18AC-SRM-220, WP003 03).

10. **Remove Horizontal Stabilizers.** Organizational maintenance, (A1-F18AC-570-300, WP021 00).

11. **Attach Aircraft Maintenance Sling to Aircraft.** Organizational maintenance, (A1-F18AC-LMM-000).

12. **Hoist Aircraft.** Intermediate and organizational maintenance, (A1-F18AC-SRM-200, WP010 02 or A1-F18AC-LMM-000).

13. **Position Aircraft on Flat Bed Trailer.** Intermediate and organizational maintenance, (A1-F18AC-SRM-200, WP010 02).

a. Pad area of flat bed trailer with old mattresses, felt padding, or rubber padding where aircraft will be positioned.

b. Using care, slowly lower aircraft onto flat bed trailer.

14. **Moor Aircraft.** (A1-F18AC-SRM-200, WP010 02).

a. Use wood, 6 feet 4X4's, nailed or bolted to flat bed trailer to prevent aircraft from shifting while being moved from crash site. See figure 1.

b. Tie aircraft down using manila rope.

c. Remove aircraft maintenance sling from aircraft.

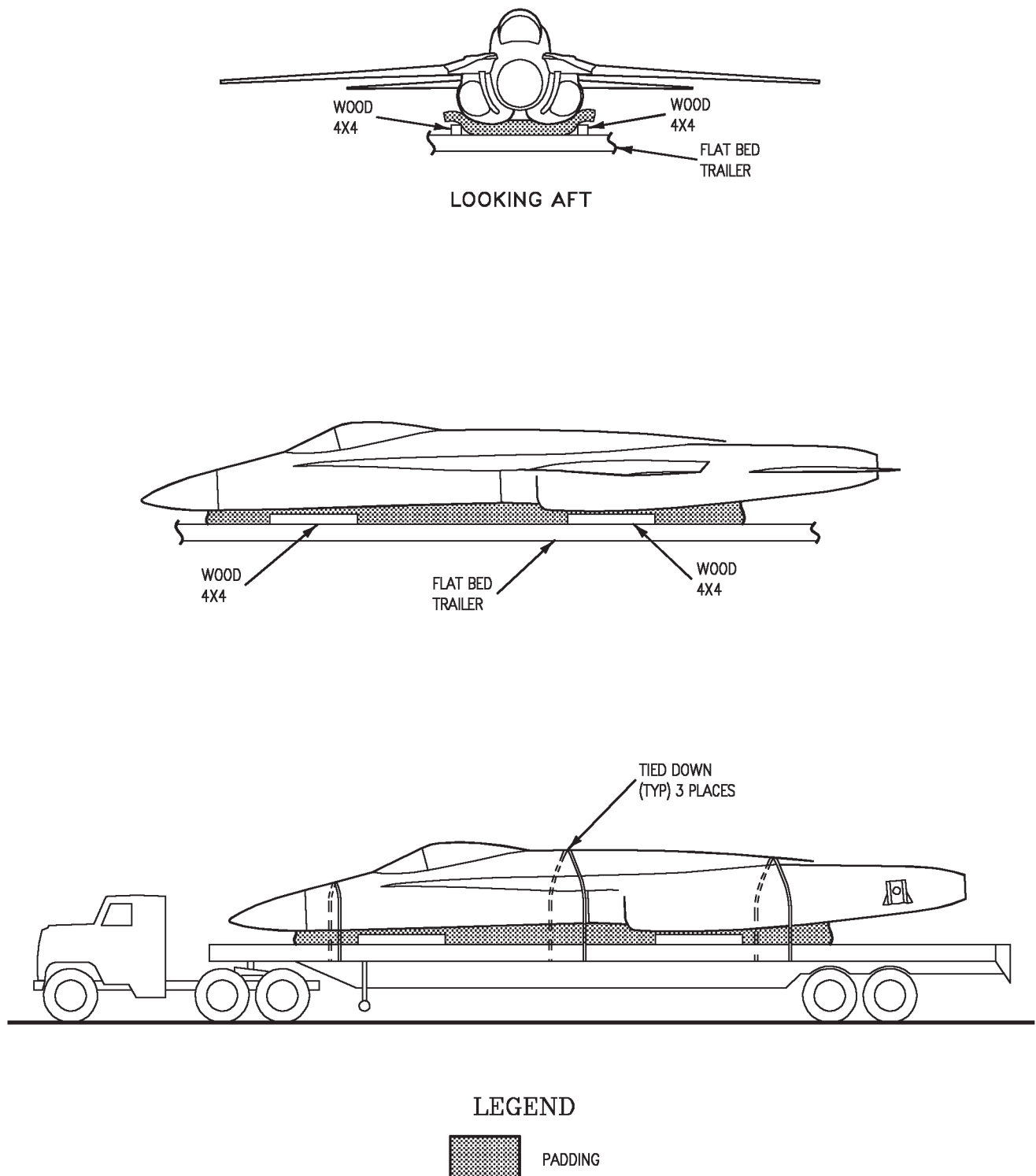


Figure 1. Use of Padding and Wood Supports

ORGANIZATIONAL MAINTENANCE**STRUCTURAL REPAIR****ADHESIVE, CEMENT, AND SEALANT; PREPARATION AND APPLICATION**

Reference Material

Aircraft Weapons Systems Cleaning and Corrosion Control.....	NAVAIR 01-1A-509
General Use of Cements, Sealants, and Coatings	NAVAIR 01-1A-507
Aircraft Corrosion Control.....	A1-F18AC-SRM-500
Form In Place Sealing.....	WP010 00
Priming Procedures	WP011 00
Finish System	WP012 00
Structure Repair, Wing.....	A1-F18AC-SRM-210
Wing Fuel Tank Channel Groove Sealing Requirements	WP019 00
Structure Repair, Aft Fuselage	A1-F18AC-SRM-240
Vertical Stabilizer Fuel Sealing	WP033 01
Structure Repair, Wing.....	A1-F18AE-SRM-600
Wing Fuel Tank Channel Groove Sealing Requirements	WP036 00
Structure Repair, Aft Fuselage	A1-F18AE-SRM-750
Vertical Stabilizer Fuel Sealing	WP037 00
Structure Repair, Typical Repair	A1-F18AC-SRM-250
Curing of Repairs.....	WP004 00
Aluminum, Graphite Epoxy, or Titanium Patch Installation and Removal....	WP007 00

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Record of Applicable Technical Directives

None

1. SEALANT PREPARATION AND APPLICATION.

2. Sealants used on aircraft are compounds. Each sealant consists of accelerators and base material. Sealants must be prepared with same care used for application on aircraft.

3. **GENERAL INFORMATION.** Additional information on preparation and storage of sealants is contained in NAVAIR 01-1A-509, NAVAIR 01-1A-507, and A1-F18AC-SRM-500.

NOTE

Prevent premature cure of sealant.
Observe table 1 application, assembly, tack free, and cure times.

a. Sealant to be used is specified in specific structure repair series manuals A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750.

b. Assembly, tack-free, and cure times, see table 1. Any increase in temperature will decrease tack-free and cure times, do not exceed 140°F.

c. Apply sealant to clean dry surfaces.

d. Surfaces cleaned for sealing shall be handled with clean cotton gloves.

e. Sealant may be applied over epoxy polyamide primer, high temperature epoxy primer, aliphatic polyurethane enamel, chemically treated, or bare metal.

f. All substructure or surfaces require solvent cleaning before sealant application.

g. Paper or synthetic non-woven wipers shall not be used for cleaning of unpainted anodized surfaces.

h. Before cleaning or application of sealant, all required assembly operations must be complete.

i. Sealant used in small amounts for repairs, may be subjected to pressure testing, water testing, or refueling after sealant has reached tack-free condition. Use short work life sealants; Class A-1/2, A-1, B-1/2, or B1.

j. Cure time may be accelerated by use of 250 watt infrared heat source, do not exceed 140°F.

k. When replacing gang channels or plate nuts, sealant to be used is specified in specific structure

repair series manuals A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750.

l. Use metal safety cans for dispensing solvents.

m. Drilling and reaming through fay sealed joints is allowed on assemblies where mating parts are pulled into contact so excess sealant is squeezed out and chip contamination in fay joint is minimized.

n. Fay seal only between skin and first layer of mating substructure in joint near form in place door seal.

o. When fay surface sealing is specified, enough sealant shall be applied to either mating surface to fill mated joint. Continuous sealant squeeze-out shall be visible around periphery of mated fay sealed structure as evidence of acceptable sealing. After determining fay joints are acceptably sealed, sealant squeeze-out shall be removed along edge of all accessible similar metal joints using wooden spatula or sealant scraper. Fay sealant squeeze-out on graphite epoxy dissimilar metal joints shall not be removed, but shall be faired into a fillet.

p. When butt joint sealing is specified, joints shall be filled to mold line flushness with sealant. Butt joints 0.20 inch gap or less do not require separate external application of sealant.

q. Where butt joint seal and multiple layers of substructure occur, apply fay sealant only between skin and mating substructure.

r. At an unsealed butt joint, example; around hinged doors or multiple layers of substructure, fay seal all layers of substructure joined by fasteners securing joint.

s. When fillet sealing is part of sealing requirements, fillets shall be continuous along joints and shall be shaped to fillet configuration with filleting tool, either during or after application.

4. SAFETY PRECAUTIONS.

a. Avoid eye or skin contact when using accelerator components, they contain reactive oxides and solvent blends, which are flammable, toxic, and irritants.

b. Avoid extended breathing of sealant vapors.

c. During spray application of sealant, operator(s) shall wear respirators. In addition, spray operator(s) in path of overspray shall wear coveralls and shall apply protective barrier cream to face and neck, use only on exposed skin.

d. Only spray operator(s) shall be allowed near area of sealant overspray.

e. Satisfactory ventilation shall be provided in solvent or sealant work areas.

f. Food or drink is prohibited in sealant or solvent work area.

g. Smoking is prohibited in sealant work area. ■

h. Only spark proof tools or equipment shall be used in sealant work area. ■

5. SEALANT PREPARATION.

Support Equipment Required

Part Number or Type Designation	Nomenclature
MIL-R-4582	Storage Freezer, -30°F or Colder
—	Quick Freeze Freezer, -90°F or Colder
—	Liquid Nitrogen Chamber
—	Water Tub, 5 Gallon
—	Thermometer, Industrial
S-O-1425	Microwave Oven, 650 Watts With Automated Interrupted Defrost Cycle. 20 Seconds Heat and 20 Seconds Soak

Materials Required

NOTE

Alternate item part numbers are shown indented.

Specification or Part Number	Nomenclature
MIL-G-43411	Leather Gloves
MIL-STD-1202 No. H016	Faceshield
UU-C-806 TYPE 2 STYLE A CLASS 1 7797	6 oz Metal Can Paper Cup, Wax Free Polyethylene Cap For Metal Can
GG-D-226 TYPE 1	Tongue Depressor, Wood Spatula
PROTEX 20X	Sand Blast Paper
—	Sealant Scraper
L-P-513-T4- PBG-0.875 220325	Plastic Sheet
—	Cartridge Assembly, 6 oz Polyethylene Cartridge with Plunger
—	Sheet Metal

Materials Required (Continued)

NOTE

Alternate item part numbers are shown indented.

Specification or Part Number	Nomenclature
MIL-S-83430	Sealing Compound, High Temperature
PR-1422	Sealing Compound, Temperature Resistant
MIL-S-81733	Sealing Compound, Sealing and Coating Compound, Corrosion Inhibitive
ZZ-G-381, TYPE 1 STYLE 1, SIZES: SMALL, MEDIUM and LARGE	Chemical Gloves, Rubber Gloves
PR-1725 B-2	Sealing Compound, Aircraft Windshields/ Windows
PR-1826 CLB-1/4, 1/2, or 2, MIL-S-29574(AS)	Sealing Compound

a. Mixing sealant:

(1) Two part sealant materials are supplied in kit form, from small unit packages of 1/2 pint to 55 gallon drum quantity.

(2) Accelerator and base compounds are matched by manufacturer to provide specific application and final physical properties. Do not mix batches of accelerator and base compounds. Use only batch of accelerator supplied with base compound.

(3) Accelerator compound shall be thoroughly mixed before blending with base compounds.

(4) Only recommended amount of accelerator shall be used for mixing with base compound. Deviation from recommended ratio will change application, cure, and end physical properties.

(5) Hand mixed materials shall be blended on clean dry metal bench top, sheet metal, or on sand blast paper covered surface. Brush type

materials shall be mixed in wax-free paper cup or metal can. Accelerator and base compounds shall be blended for approximately 5 to 7 minutes or mixed to smooth homogeneous mixture.

(6) After mixing, sealant shall be placed in polyethylene cartridges or metal cans, used immediately, or quick-frozen.

(7) When damaged container causes transfer of material to new container, transfer all relative label information to new container.

b. Mixing MIL-S-83430, PR-1422, or MIL-S-81733 sealing compounds. MIL-S-83430 is high temperature sealing compound, PR-1422 is temperature resistant sealing compound, and MIL-S-81733 is corrosion inhibitive sealing and coating compound. Mix compound per substeps below:

WARNING

Sealant materials are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

NOTE

Amount of accelerator mixed with specific amount of base compound is specified by weight on base compound container, to get the class sealing compound required.

(1) Mix accelerator to smooth paste before combining with base material.

NOTE

Mixing must be done slowly to prevent trapping air in mixture.

(2) Determine amount of accelerator to be mixed with base compound.

NOTE

Mix only amount of material to be used in 1 hour.

(3) Combine accelerator with base compound. Thoroughly mix recommended amounts using wood spatula on clean surface.

(4) Mix to smooth homogenous mixture.

b1. Mixing PR-1725 B-2 sealing compound.

WARNING

(1) PR-1725 B-2 sealing compound is two part polysulfide liquid polymer compound.

(2) Kits consist of correct amounts of base compound and accelerator. All contents shall be mixed at one time.

(3) Mix bulk material one part, by weight, of accelerator with 10 parts, by weight, of base compound.

(4) Thoroughly stir accelerator in its container until even consistency is visible.

(5) Slowly stir accelerator into base compound and thoroughly mix, approximately 7 to 10 minutes. Be sure to scrape sides and bottom of container to get all compound into mix and get uniform blending. Scrape mixing paddle periodically to remove unmixed compound. It is recommended to mix compound slowly by hand.

b2. Mixing PR-1826 Sealing Compound.

WARNING

Sealant materials are flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

(1) PR-1826 is rapid curing integral fuel tank sealant for use at temperatures between -65° to 360° F.

(2) It is two-part chemically curing sealant characterized by rapid cure at low temperatures to fuel resistant rubber.

(3) Kits consist of correct amounts of compound and accelerator. Contents shall be mixed per instructions on container.

c. Identification of mixed sealants:

(1) Manufacturers designation, example; MIL-S-83430.

(2) Class and dash number, example; A-1/2.

(3) End use date, this is determined by adding storage time permitted, dependent on freeze method, to mix date.

(4) For newly mixed sealants used without cold storage, mark containers with date and time of mixing.

d. Freezing methods:

(1) Method I, dry box freezing and method II, liquid nitrogen freezing are most common freezing methods for sealant.

(2) Method I, dry box freezing, is quick-freeze method which subjects sealant to -130° to -90° F for approximately 20 minutes, not used for Class A-1/2, B-1/4, B-1/2, B-1 sealant.

WARNING

Protective clothing required; gloves, coveralls, high top shoes, and face shield. Use in well ventilated area. Physical contact with liquid nitrogen requires immediate medical attention. Remove contaminated clothing and flush exposed area(s) with large quantities of unheated tap water. Get medical aid immediately.

(3) Method II, liquid nitrogen freezing, is quick-freeze method that subjects sealant to liquid nitrogen for 2 minutes bringing sealant to -30° F. There are no class or application life restrictions with this method.

e. Storage of mixed sealant:

(1) Sealant may be used immediately after mixing, this will allow maximum application life, see table 1.

(2) Sealant may be purchased in premixed and frozen condition when facilities are not available for mixing and quick-freezing. Sealants purchased in this condition may be stored at -40° F or colder for maximum of 21 days.

(3) Store quick-frozen Class B-2 and Class B-4 sealant at 0° F or colder for no more than 96 hours.

(4) Store quick-frozen Class A-2 and Class A-4 sealant at 0° F or colder for no more than 48 hours.

(5) Store liquid nitrogen quick-frozen sealant at -30° F or colder for no more than 12 days.

f. Thawing instructions:

(1) Thaw frozen sealant at ambient, room, temperature for 30 minutes minimum or by placing in $120 \pm 5^{\circ}$ F water bath for approximately 4 minutes. This is used for both frozen sealant methods.

(2) Method II frozen sealant may be placed in microwave for approximately 2 minutes. Oven must have interrupted defrost cycle, 20 seconds heat and 20 seconds soak. Sealant will have subsequent application life approximately 25 to 30 percent less than fresh mix sealant.

6. SEALANT APPLICATION. Sealant systems are applied to aircraft structure and skins for prevention of; water/moisture entry, chemical damage, dissimilar metal contact, fuel leaks, pressure leaks, fume entry, and provide contour smoothness.

Support Equipment Required

NOTE

Alternate item type designations or part numbers are listed in parentheses.

**Support Equipment Required
(Continued)**

Part Number or Type Designation	Nomenclature
P-MBC-510	DeVilbiss Spray Gun with Suction Cup
704-E	DeVilbiss Fluid Tip, 0.070 Inch I.D.
704 (MBC-444-E)	DeVilbiss Fluid Needle
AV-601-E (AV-1239)	DeVilbiss Air Cap
—	Stiff Bristle Brush
TD-596A	Filleting Tool
MIL-V-21987	Air Operated Vacuum Cleaner
—	Rubber, Teflon, Polyethylene Spatula
Semco No. 250	Pneumatic Sealant Gun
Semco No. 8615	Sealant Gun Nozzle
Semco No. 440 (No. 420)	Sealant Gun Nozzle
—	250 Watt Infrared Heat Source

Materials Required**NOTE**

Alternate item part numbers are shown
indented.

Specification or Part Number	Nomenclature
MILA9962TY1 CL1GRAX9X11	Abrasive Mat
—	Sealant Scraper
DS-108F 5772 048	Solvent, Wipe Cleaning Compound
—	Spatula, Hard Rubber, Teflon, Polyethylene
MIL-S-83430	Sealing Compound, High Temperature

Materials Required (Continued)**NOTE**

Alternate item part numbers are shown
indented.

Specification or Part Number	Nomenclature
MIL-S-8802	Sealing Compound, Temperature Resistant
MIL-S-81733	Sealing Compound, Sealing and Coating Compound, Corrosion Inhibitive
CCC-C-440 TYPE 1 CLASS 1	Cheesecloth
CCC-C-46, TYPE 1, CLASS 4	Cleaning Cloth, Nonwoven Fabric
AA1048TY1CL1 GRIT240X9X11	Aluminum Oxide Abrasive Cloth
A-A-883, TYPE 1	Pressure Sensitive Tape, Masking Tape
A-A-203	Untreated Kraft Paper
H-B-695 TYPE1 GRADEA SIZE 1 or 2	Varnish Brush, Flat, 1/4 to 3 Inches Wide
GG-D-226 TYPE 1	Tongue Depressor, Wooden Spatula
NO. 10/20 GROUND CORK	Filler Material
CRUSHED CORK MIL-G-81322	Filler Material
MIL-C-16173, GRADE 2	Aircraft Grease, General Purpose
MIL-P-23377, TY1, CL1	Corrosion Prevention Compound
MIL-P-23377, TY2, CL1	Primer, Interior Surfaces
PR-1826 CLB-1/4, 1/2, or 2, MIL-S- 29574(AS)	Primer, Mold Line Surfaces
	Sealing Compound

7. **FAY SURFACE SEALING.** See figure 1.

WARNING

Solvent should be used with care. Gloves must be worn to prevent injury.

a. Clean mating surfaces using clean cheesecloth moistened with solvent.

b. Allow surface to air dry 15 minutes before applying sealant.

c. Apply class A or B sealant to one mating surface using pneumatic sealant gun equipped with fay sealing sealant gun nozzle, No. 8615. Apply two















continuous beads of sealant centered between fastener hole pattern and each edge of part.

d. Place parts in assembly position immediately after sealant application. Install enough temporary fasteners to pull faying surfaces into contact and squeeze out excess sealant before installing permanent fasteners. Install permanent fasteners with wet sealant within assembly time specified in table 1. When not possible to install all permanent fasteners within assembly time, complete operation by clamping with temporary fasteners. Install permanent fasteners with wet sealant when replacing temporary fasteners.







Table 1. Sealant Class, Application, and Cure Information

Sealant Spec	CL	Appl	Appl Time (HR) 4 1	Assy Time (HR) 4	Approx Tack Free Time (HR) 4	Approx Cure Times (HR) 4
MIL-S-81733	I - 1/2	Brush	1/2	1	10	30
	I - 2	Brush	2	4	18	48
	II - 1/2	Gun	1/2	1	10	30
MIL-S-8802 (PR-1422)	II - 2	Gun	2	4	18	48
	II - 4	Gun	4	8	24	72
	IV - 12	Brush/Gun	12	20	N/A	8 Days
	IV - 24	Brush/Gun	24	80	N/A	10 Days
	A - 1/2	Brush	1/2	1 2	10	18
	A - 1	Brush	1	2 2	14	22
	A - 2	Brush	2	4	18	28
	A - 4	Brush	4	8	30	40
	B - 1/2	Gun	1/2	1 2	8	16
	B - 1	Gun	1	2 2	12	20
	B - 2	Gun	2	4	16	24
	B - 4	Gun	4	8	26	36

Table 1. Sealant Class, Application, and Cure Information (Continued)

Sealant Spec	CL	Appl	Appl Time  (HR) 	Assy Time (HR) 	Approx Tack Free Time (HR) 	Approx Cure Times (HR) 
PR-1440	A - 1/2	Brush	1/2	1 	8	28
	A - 1	Brush	1	2 	12	36
	A - 2	Brush	2	4	16	48
	A - 4	Brush	4	8 	30	96
	B - 1/4	Gun/Spatula	1/4		4/12	14
	B - 1/2	Gun/Spatula	1/2	1 	8	24
	B - 1	Gun/Spatula	1	2 	12	36
	B - 2	Gun/Spatula	2	4	16	48
	B - 4	Gun/Spatula	4	8	30	96
	B - 6	Gun/Spatula	6	12	48	120

NOTES

-  Application time and assembly time are not additive. Application time and assembly time starts at time sealant is mixed or thawed. Dash number after class will tell application time.
-  Do not use Class A-1/2, B-1/2, A-1, or B-1 for fay surface sealing.
-  Heat Resistance, 360°F - 1 Hour or Less
325°F - 4 Hours or Less
-65 to 250°F Long term
-  Based on 75°F and 50 percent relative humidity.
-  Mandatory use for sealing on bonded assemblies and composites. Preferred for all other applications.
-  Meets requirements of MIL-S-83430.

e. If either mating part of joint to be fay sealed is 0.020 inches or less thickness, use class A sealant to minimize waviness between fasteners. Use class B sealant when thickness of each mating part is greater than 0.020 inches.

NOTE

Class A sealant may be used as fay sealant on joints to be machine riveted.

f. When graphite epoxy is one material of dissimilar metal joint, apply fay sealant so squeeze-out can be used to form fillet, per figure 1, around periphery of mated joint on interior surface. Fair sealant squeeze-out into fillet configuration during application life of sealant.

g. After determining fay sealed joints are acceptably sealed, remove sealant squeeze-out along edge of all accessible similar metal joints with

sealant scraper. Do not remove sealant squeeze-out along graphite epoxy dissimilar metal joints.

h. When replacing gang channels and plate nuts, sealant to be used is specified in specific structure repair series manuals A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750.

i. Remove excess quantities of sealant around fastener patterns on interior structure. Meticulous cleanup around fastener patterns is not required as only excess quantities of sealant must be removed to reduce weight.

j. Painting of sealant squeeze-out or fillets on interior surfaces is not required for appearance or color uniformity; however, painting of these areas is not wrong. Repair all finish system damage resulting from cleaning or sealing operations with initial finish system (A1-F18AC-SRM-500, WP011 00 and WP012 00).

WARNING

Solvent should be used with care. Gloves must be worn to prevent injury.

Cleaning compound may cause skin irritation. Avoid contact with skin and clothing. Wash thoroughly after handling.

k. Remove sealant which extrudes through fastener holes, faying surfaces, and butt joints onto exterior with clean cheesecloth moistened with solvent or cleaning compound. Remove sealant immediately after installation of skins and before sealant cures.

8. FAY SURFACE SEALING OF SPECIAL AREAS.

Special areas are where sealant cannot be applied during installation of skin because there are no fasteners installed to complete clamp up.

a. After all assembly operations or repairs have been completed, lift edge of skin or part enough to allow removal of chips from seal area with vacuum.

WARNING

Solvent should be used with care. Gloves must be worn to prevent injury.

b. Clean special area(s) immediately before application of sealant using clean cheesecloth moistened with solvent.

c. Allow surface to air dry 15 minutes before applying sealant.

d. Insert nozzle of sealant gun by carefully lifting edge of skin or part. With tip of sealant gun inserted, inject class B sealant.

e. Install fasteners within assembly time allowed in table 1.

f. Remove excess sealant with sealant scraper.

9. JOGGLE SEALING. See figure 1.

a. Force sealant into one side of joggle cavity with pneumatic sealant gun until sealant appears from opposite side of cavity.

b. Fair sealant into fillet configuration with wooden spatula or filleting tool.

WARNING

Solvent should be used with care. Gloves must be worn to prevent injury.

Cleaning compound may cause skin irritation. Avoid contact with skin and clothing. Wash thoroughly after handling.

c. Remove excess sealant that extrudes through fastener holes, faying surfaces, and butt joints onto exterior skins with clean cheesecloth moistened with solvent or cleaning compound.

10. FILLET SEALING. See figure 1.

WARNING

Solvent should be used with care. Gloves must be worn to prevent injury.

a. Clean all joints to be fillet sealed with clean cheesecloth moistened with solvent.

b. Allow surface to air dry 15 minutes before applying sealant.

NOTE

Use class B sealants for fillet sealing.

c. Using pneumatic sealant gun, apply sealant by extruding continuous bead of material along edge of joint. When applying fillet seal, point sealant gun nozzle into joint and keep gun nearly perpendicular to direction of travel. Regulate sealant extrusion rate so bead of sealant is before tip of sealant gun nozzle.

d. On lap joint with step or material thickness which exceeds 0.150 inch, use Semco sealant gun nozzle no. 440 or 420. Cut sealant gun nozzle off to get correct fillet size. On lap joint with step or material thickness which is 0.150 or less, use Semco sealant gun nozzle no. 8615 trimmed to correct fillet contour, see figure 1.

e. Final fillet configuration is formed with sealant gun nozzle during application or by forming fillet with filleting tool. To shape fillet, press filleting tool against sealant and move parallel to bead.

f. Exercise caution to prevent folds, voids, and entrapment of air during application and shaping of fillet. Work out any visible air bubbles during application life of sealant.

11. BUTT JOINT SEALING. See figure 1. Butt joint sealing should be done on subassemblies or for repairs immediately after fay surface sealing is completed. This sequence will minimize amount of contamination of joints before butt joint sealing.

WARNING

Solvent should be used with care. Gloves must be worn to prevent injury.

a. Clean splice joints and contaminated butt joints with stiff bristle brush and solvent.

b. Allow surface to air dry 15 minutes before applying sealant.

c. Inject sealant into butt joint with pneumatic sealant gun with small orifice sealant gun nozzle. Position sealant gun nozzle in or over butt joint and inject sealant with gun approximately perpendicular to surface and line of travel. Regulate extrusion rate so sealant will be forced into joint and small bead will remain on joint surface, see figure 1.

d. After sealant injection, complete operation by allowing sealant to cure to tack-free condition, then use sealant scraper to trim flush with skin surface or fair uncured sealant to mold line flushness using hard rubber, teflon, or polyethylene spatula held at approximately 45 degrees to line of travel.

WARNING

Solvent should be used with care. Gloves must be worn to prevent injury.

Cleaning compound may cause skin irritation. Avoid contact with skin and clothing. Wash thoroughly after handling.

e. Use clean cheesecloth moistened with solvent or cleaning compound to remove excess cured sealant.

12. FOREIGN OBJECT (F.O.) SEALING. Foreign object sealing is done to prevent entrapped objects

from entering or leaving sealed compartment or area. Sealant application, paragraph 6, is used for foreign object sealing to fill gaps, holes, joggles, or slots. Use type IV, class B sealant.

a. Remove damaged sealant with sealant scraper.

WARNING

Solvent should be used with care. Gloves must be worn to prevent injury.

b. Clean surface around holes, slots, or gaps with clean cheesecloth moistened with solvent.

c. Allow surface to air dry 15 minutes before applying sealant.

d. Mask surrounding area(s) with masking tape and untreated kraft paper.

e. Inject sealant with sealant gun equipped with Semco 440 sealant gun nozzle, see figure 1.

f. Use filleting tool or wooden spatula to form desired seal contour.

NOTE

Use filler, and type IV, class B sealant to aid filling gaps between wire bundles and conduit, wire bundles and bulkhead, conduit and bulkhead, fluid lines and bulkhead, or fluid lines with gaps which exceed 0.500 inch.

g. Seal large spaces with mixture of filler, and type IV, class B sealant as listed below:

(1) Mix filler and sealant in volume ratio of 1 part sealant to 2.5 parts filler.

h. When filler is used, apply heavy top coat type IV, class A sealant to prevent filler from wicking fuel or moisture.

i. Use filleting tool or wooden spatula to form desired seal contour.

j. Remove masking tape and untreated kraft paper.

13. FUME SEALING. Fume sealing is done to prevent fumes or gases from entering or escaping

from a compartment(s). Apply fillets on pressure side of compartment or area being sealed. Sealing on nonpressurized side of joint or opening is allowed when pressure side is inaccessible.

a. All holes, slots, joggles, and wire bundles shall be sealed. Enclosure joints making up fume boundary shall be fillet sealed per paragraph 10.

b. For large holes, 0.500 inch or larger, seal per paragraph 15.

14. **FASTENER SEALING.** See figures 2 and 3.

WARNING

Solvent should be used with care. Gloves must be worn to prevent injury.

a. Clean dimples, countersinks, non-flush fastener hole patterns, and surrounding area with clean cheesecloth moistened with solvent.

b. Allow surface to air dry 15 minutes before applying sealant.

c. All permanent fasteners, except aluminum rivets or fast rivets in aluminum skins and structures, installed in mold line areas shall be installed wet using MIL-S-81733 or MIL-S-8802 sealant per table 1. If wet installation with sealant is not consistent with maintenance objectives, fasteners shall be over coated with sealant.

(1) Apply small bead or layer of sealant around fastener shank, countersink, dimple, or conical area of fastener head with sealant gun or brush. Sealant application may be made before inserting fastener, or after inserting fastener 1/2 shank length. Sealant squeeze-out shall be visible completely around fastener head.

(2) When installing permanent mold line fasteners through wing integral fuel tanks sealant channel, apply sealant to conical area of fastener head only after starting fastener in hole. Wet sealant application to fasteners installed in wing torque box must be made in such manner to keep sealant out of fuel tank, plate nuts, and channel sealant grooves.

(3) Hi-Lok fasteners installed through pressure boundaries, fuel boundaries, or forward of engine air inlets shall include sealant under head

and on threads. Sealant squeeze-out shall be visible completely around head and around both ends of installed collar.

WARNING

Solvent should be used with care. Gloves must be worn to prevent injury.

Cleaning compound may cause skin irritation. Avoid contact with skin and clothing. Wash thoroughly after handling.

(4) Remove sealant which extrudes out around fasteners immediately after fastener installation using clean cheesecloth moistened with solvent or cleaning compound.

d. Fast rivets are wet installed with mold line surface primer, MIL-P-23377, TY2, CL1.

e. Aluminum rivets are installed wet with interior surface primer, mold line surface primer, or high temperature epoxy primer.

f. For interior or exterior applications, dissimilar metal fasteners and part contact, which involve adjustable interfaces and require frequent disassembly and removal shall be wet installed using aircraft general purpose grease or corrosion preventive compound. If wet installation with grease is undesirable, bolts and nuts shall be oversealed using sealant per table 1.

g. When sealing gang channels and plate nuts, sealant to be used is specified in specific structure repair series manuals A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750.

15. **PRESSURE SEALING.** Pressure sealing is done to maintain pressurization. Pressure sealing may use any application described in this work package, except foreign object sealing.

16. **FORM IN PLACE SEALING.**
(A1-F18AC-SRM-500, WP010 00).

17. **CHANNEL GROOVE SEALING.** Channel groove sealing, see figure 1, consists of injecting sealing compound through selected fastener holes into channel formed by machined groove in one part and mating surface of adjoining part. Sealing compound does not cure providing a flexible seal which is

renewable without disassembly of mating surfaces.
For specific channel groove sealing;
A1-F18AC-SRM-210, WP019 00 or
A1-F18AE-SRM-600, WP036 00 and
A1-F18AC-SRM-240, WP033 01 or
A1-F18AE-SRM-750, WP037 00.

18. **VOID SEALING.** Unsupported holes or slots shall be sealed with gun grade, class B sealant. See figure 1.

19. APPLICATION OF PR-1725 B-2 SEALING COMPOUND.

a. Application life for PR-1725 B-2 sealing compound is time mixed compound remains at consistency suitable for application with spatula or gun.

b. Standard application life is 75 degrees and 50 percent relative humidity.

(1) Increase temperature 10 to 15 degrees F. decreases application life one-half.

(2) Decrease temperature 10 to 15 degrees F. life is doubled.

(3) High humidity at time of mixing shortens application time.

c. Nonstructural material for bonding metal to metal or glass to glass.

(1) Apply 0.010 to 0.015 thick film to one surface.

NOTE

Do not handle bonded joints until cure is complete.

(2) Join surfaces with enough pressure to allow full contact and air cure.

20. APPLICATION OF PR-1826 SEALING COMPOUND.

a. Application life for PR-1826 sealing compound is time mixed compound remains at consistency suitable for application with spatula or gun.

b. Standard application life is at 20° to 77° F and 50 percent relative humidity, see table 2.

**Table 2. PR-1826/MIL-S-29574
Application Time**

Class	Temp ° F.	Application Time (Hours)
B-1/4	77	1/4
	40	1/4
	20	1/4
B-1/2	77	1/2
	40	1/2
	20	1/2
B-2	77	2
	40	2
	20	2

c. For integral fuel tanks;

WARNING

Solvent should be used with care. Gloves must be worn to prevent injury.

(1) Thoroughly clean area(s) before sealant application using clean cheesecloth moistened with solvent.

(2) Allow area(s) to dry for 15 minutes before priming.

(3) Apply PR-1826 primer, per instructions on container, using brush or clean cleaning cloth formed in pad. Allow to dry 30 minutes before overcoating.

(4) Apply PR-1826 sealing compound, 1/8 to 3/16 inch thick, to repair area(s) with spatula.

(5) Firmly press sealant in place to desired shape. Lap PR-1826 over old sealant from 1/8 to 1/4 inch.

(6) Allow sealant to cure until stiff. Apply heat, not to exceed 130° F, to shorten core.

d. For pressurized cabins;

(1) Thoroughly clean area(s) before sealant application using clean cheesecloth moistened with solvent.

(2) Allow area(s) to dry for 15 minutes before priming.

(3) Apply PR-1826 primer, per instructions on container, using brush or clean cleaning cloth formed in pad. Allow 30 minutes to dry before overcoating.

(4) Apply PR-1826 sealing compound, 1/8 inch thick, to repair area(s), using spatula.

(5) Firmly press sealant in place to desired shape.

(6) Allow PR-1826 sealing compound to cure until stiff.

(7) Apply heat, not to exceed 130° F., to shorten cure time.

21. CURE TIME FOR PR-1826 SEALING

COMPOUND. Cure time for PR-1826 sealing compound is considered to be rapid, see table 3.

**Table 3. PR-1826/MIL-S-29574
Cure Time**

Class	Temp ° F .	Cure Time (Hours)
B-1/4	77	1.5
	40	4.0
	20	8.0
B-1/2	77	3.0
	40	8.0
	20	16.0
B-2	77	14.0
	40	32.0
	20	64.0

22. ADHESIVE PREPARATION AND APPLICATION.

23. Adhesives used on aircraft are compounds. Most adhesives consists of accelerators and base material. These adhesives must be prepared with same care used for application on aircraft.

24. GENERAL INFORMATION.

- Apply adhesive to clean dry surfaces.
- Surfaces cleaned for adhesives shall be handled with clean cotton gloves.
- All substructure or surfaces require solvent cleaning before adhesive application.

d. Paper or synthetic non-woven wipers shall not be used for cleaning of unpainted anodized surfaces.

25. SAFETY PRECAUTIONS.

- Avoid eye or skin contact when using accelerator components, they contain reactive oxides and solvent blends which are flammable, toxic, and irritants.
- Avoid extended breathing of adhesive vapors, they are toxic.
- Satisfactory ventilation shall be provided in adhesive work area.
- Food or drink is prohibited in adhesive work area.
- Smoking is prohibited in adhesive work area.
- Only spark proof tools or equipment shall be used in adhesive work area.

26. ADHESIVE PREPARATION.

Support Equipment Required

Part Number or Type Designation	Nomenclature
—	Balance Scale, Trip, 0.10 Gram Graduations

Materials Required

NOTE

Alternate item part numbers are shown indented. ■

Specification or Part Number	Nomenclature
MIL-STD-1202	Face Shield
ZZ-A-605	Rubber Apron
ZZ-G-381, TYPE 1, STYLE 1, SMALL, MEDIUM, AND LARGE	Chemical Gloves, Rubber Gloves

Materials Required (Continued)**NOTE**

Alternate item part numbers are shown indented.

**Specification
or Part Number****Nomenclature**

UU-C-806 TYPE 2	Paper Cup,
STYLE A CLASS 1	Wax Free
GG-D-223	Metal Spatula
GG-D-226	Wood Spatula,
TYPE 1	Tongue Depressor
EA934	Adhesive
EA9309A/B	Adhesive
EA960F	Adhesive

27. Mixing Adhesives:**NOTE**

For storage, preparation, and handling procedure for EA956 and EA9321 structural paste adhesives (A1-F18AC-SRM-250, WP 003 00)

a. EA934 adhesive. This adhesive is two part compound.

WARNING

EA934 adhesive is toxic. Avoid breathing of vapors. Avoid contact with skin or eyes. Wear gloves and goggles while handling. If eye contact is made, wash immediately with large amount of water. If skin contact is made, wash immediately with soap and water.

NOTE

Mix only amount of materials to be used in 40 minutes.

(1) Combine by weight, 100 parts of part A with 33 parts of part B.

(2) Mix two compounds thoroughly; EA934 adhesive will be uniform in color when mixed.

(3) Allow EA934 adhesive to set 5 minutes for air bubble removal before application.

WARNING

EA956 adhesive is toxic. Avoid breathing of vapors. Avoid contact with skin or eyes. Wear gloves and goggles while handling. If eye contact is made, wash immediately with large amount of water. If skin contact is made, wash immediately with soap and water.

NOTE

Mix only amount of materials to be used in 40 minutes.

(4) Combine by weight, 100 parts of part A with 58 parts of part B.

(5) Mix two compounds thoroughly; EA956 adhesive will be uniform in color when mixed.

(6) Allow EA956 adhesive to set 5 minutes for air bubble removal before application.

b. EA960F adhesive. This adhesive is two part compound.

WARNING

EA960F adhesive is toxic. Avoid breathing of vapors. Avoid contact with skin or eyes. Wear gloves and goggles while handling. If eye contact is made, wash immediately with large amount of water. If skin contact is made, wash immediately with soap and water.

NOTE

Mix only amount of materials to be used in 40 minutes.

(1) Combine by weight, 100 parts of part A with 50 parts of part B.

(2) Mix two compounds thoroughly; EA960F adhesive will be uniform red color when mixed.

(3) Allow EA960F adhesive to set 5 minutes for air bubble removal before application.

WARNING

EA9321 A/B adhesive is toxic. Avoid breathing of vapors. Avoid contact with skin or eyes. Wear gloves and goggles while handling. If eye contact is made, wash immediately with large amount of water. If skin contact is made, wash immediately with soap and water.

NOTE

Mix only amount of materials to be used in 40 minutes.

(4) Combine by weight, 100 parts of part A with 50 parts of part B.

(5) Mix thoroughly two compounds; EA9321 A/B adhesive will be uniform in color when mixed.

c. EA9309 A/B adhesive. This adhesive is two part compound.

WARNING

EA9309 A/B adhesive is toxic to skin, eyes, and respiratory tract. Skin and eye protection required. Avoid repeated or prolonged contact. Good general ventilation is normally enough.

NOTE

Mix only amount of materials to be used in 40 minutes.

(1) Combine by weight, 100 parts of part A with 23 parts of part B.

(2) Mix two compounds thoroughly; EA9309 A/B adhesive will be uniform in color when mixed.

(3) Allow EA9309 A/B adhesive to set 5 minutes for air bubble removal before application.

28. ADHESIVE APPLICATION AND CURING.**Support Equipment Required**

Part Number or Type Designation	Nomenclature
—	250 Watt Infrared Heat Source
74D110165-1001	Repair Set Temperature/Vacuum, Control, Composite Structure
MS3101R16-10P	Connector Plug Electric

Materials Required**NOTE**

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
CCC-C-440 TYPE 1 CLASS 1	Cheesecloth
CCC-C-46, TYPE 1, CLASS 4	Cleaning Cloth
D 1153	Methyl Isobutyl Ketone
EA934	Adhesive
EA9309A/B	Adhesive
EA960F	Adhesive
MIL-C-87962, TYPE 1	Cleaning Cloth
PATTERN 30	Nylon Cloth, Scrim Cloth

NOTE

Adhesive to be used is specified in specific structure repair series manuals A1-F18AC-SRM-210 thru A1-F18AC-SRM-240 or A1-F18AE-SRM-600 thru A1-F18AE-SRM-750.

a. Application of EA934, EA956, EA9321 A/B, and EA9309A/B adhesive.

(1) Apply thin film of mixture to both surfaces.

(2) Lay 1 layer of scrim cloth on top of adhesive.

(3) Assemble immediately.

(4) Apply pressure to get complete contact.

WARNING

Methyl isobutyl ketone is flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

(5) Remove squeeze out with cleaning cloth or paper wiper, moistened with methyl isobutyl ketone.

b. Application of EA960F adhesive, fairing and smoothing compound.

WARNING

Methyl isobutyl ketone is flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

(1) Clean surface to be worked with clean methyl isobutyl ketone moistened cloth.

(2) Apply film of adhesive to surface as required for fairing or smoothing.

(3) Cure per step d. below.

(4) Compound can be sanded or painted as required.

c. EA934 and EA9309 A/B adhesives are cured by one of two methods.

(1) Air cure method: Allow to cure at room temperature, 75°F, for 5 days.

CAUTION

If using heat cure method, do not exceed 200°F or damage to assembly may occur.

(2) Heat Cure Method: Use 250 watt infrared heat source, not exceeding 200°F, for 1 hour. Connect infrared heat source to 74D110165-1001 repair set with MS3101R16-10P connector.

d. EA960F adhesive is cured by one of two methods.

(1) Air cure method: Allow to cure at room temperature, 75°F, for 24 hours.

CAUTION

If using heat cure method, do not exceed 160°F or damage may occur.

(2) Heat Cure Method: Use 250 watt infrared heat source, not exceeding 160°F, for 1 hour. Connect infrared heat source to 74D110165 repair set with MS3101R16-10P connector.

29. SEALING COMPOUND, MIL-S-83430 (AMS 3276). This material is a high temperature sealing compound. Mix compound per steps below:

Support Equipment Required

Part Number or Type Designation	Nomenclature
—	Scale, Balance, Trip, 0.10 Gram Graduations

Materials Required**NOTE**

Alternate item part numbers are shown indented.

**Specification
or Part Number****Nomenclature**

UU-C-806, STYLE A, CLASS 1, TYPE 1 or 2	Paper Cup
ZZ-G-381	Rubber Gloves
MIL-S-83430	Sealing Compound
AMS 3276	Sealing Compound
GG-D-223	Metal Spatula

WARNING

Sealing compound is flammable and toxic to eyes, skin, and respiratory tract. Skin/eye protection required. Avoid repeated/prolonged contact. Use only in well ventilated areas. Keep away from open flames or other sources of ignition.

NOTE

The amount of accelerator mixed with a specific amount of base compound is specified by weight on the base compound container, to get the class sealing compound required.

a. Mix accelerator to a smooth paste before combining with base material.

NOTE

Mixing must be done slowly to prevent trapping air in the mixture.

b. Determine amount of accelerator to be mixed with base compound.

NOTE

Mix only amount of material that will be used in 1 hour.

c. Combine accelerator with base compound. Thoroughly mix the recommended amount using a metal spatula on a clean surface.

d. Mix to a smooth homogenous mixture.

30. CURING OF MIL-S-83430 (AMS 3276) SEALING COMPOUND. MIL-S-83430 (AMS 3276) sealing compound is cured to full strength by air cure or heat cure methods.

31. Air Cure Method. MIL-S-83430 (AMS 3276) sealing compound will be tacky in 12 hours and will full cure in 36 hours. This method is based on a temperature of 77°F and 50 percent relative humidity. Any increase or decrease in temperature and humidity will affect work life and cure time of MIL-S-83430 (AMS 3276) sealing compound.

32. Heat Cure Method. Procedures to cure MIL-S-83430 (AMS 3276) sealing compound using 4230-103, -109 and MDA151-002 heat blankets or AM-D-O-MDA1S1-101, -103, -105, and -107 heat/vacuum blankets are given below.

33. MIL-S-83430 (AMS 3276) Sealing Compound Using 4230-103, -109, and MDA151-002 Heat Blankets. See figure 1.

Support Equipment Required**NOTE**

Alternate type designations or part numbers are listed in parentheses

**Part Number or
Type Designation****Nomenclature**

4230-103	Heat Blanket
4230-109	Heat Blanket
MDA151-002	Heat Blanket
74D110165-1001 (1935AS100-1)	Repair Set, Temperature/ Vacuum Control, Composite Structure

Materials Required**Specification****or Part Number****Nomenclature**

TEMP-R-GLAS 6TB	Cloth, Teflon
855-1.000IN.	Pressure Sensitive Tape
200SG40TR	Plastic Sheet
QQ-C-576, Type ETP	Copper Sheet, 0.020 Inch Thick
MIL-C-9084 TYPE 8, CLASS 2	Cloth, Satin

a. Cover repair with plastic sheet 1 inch past periphery of repair.

b. Position layer of satin cloth over repair. Cut cloth 6 inches longer and 1-1/2 inches wider than heat blanket (6). Tape edges of cloth with pressure sensitive tape.

c. Cut a piece of 0.020 copper sheet as large as repair area.

NOTE

Teflon cloth positioned between satin cloth and copper sheet prevents sealing compound bleedout from curing to copper sheet.

d. Cut layer of teflon cloth same size as copper sheet. Position teflon cloth over satin cloth.

e. Center 0.020 copper sheet over layer of teflon cloth.

NOTE

A temperature sensor/ probe assembly is required for control of the 4230-103, -109, and MDA151-002 heat blankets (6). Increased size of repair area or extremes of ambient temperature may require extra temperature sensors beneath heat blanket.

f. Position temperature sensor/ probe assembly on top of copper sheet near center of repair. Tape in position with pressure sensitive tape.

g. Cover copper sheet with one more layer of satin cloth, same size as step b. Tape edges of cloth with pressure sensitive tape.

h. Center heat blanket (6) over satin cloth and tape in position with pressure sensitive tape.

i. Connect 74D110165-1001 repair set to repair arrangement per substeps below. For 1935AS100-1 repair set (NAVAIR 17-1-131, WP005 00).

(1) Connect cable assembly (1) to temperature control assembly (2) and facility power.

(2) Connect cable assembly (4) to temperature control assembly (2) and to temperature sensor assembly (5).

(3) Connect cable assembly (8) to temperature control assembly (2) and to cable assembly (7).

(4) Connect sensor branch of cable assembly (7) to temperature sensor assembly (5).

(5) Connect power branch of cable assembly (7) to heat blanket (6).

(6) Set MASTER POWER switch on temperature control assembly (2) to ON. Do lamp test, battery test, and overtemp alarm test. After test, set MASTER POWER switch to OFF.

j. Set up equipment as per substeps below:

WARNING

Do not exceed 140°F, as personal injury and/or more damage to structure may occur if water/moisture exists.

(1) Set cure temperature to 140°F.

(2) Set rise rate to 4°F per minute.

(3) Set cure time to 3 hours.

k. For 74D110165-1001 repair set, do substeps below. For 1935AS100-1 repair set (NAVAIR 17-1-131, WP 005 00).

(1) Select channel to be displayed on indicator module(s).

(2) Select temperature sensor input to be recorded with printer source switch. Record highest bond line temperature.

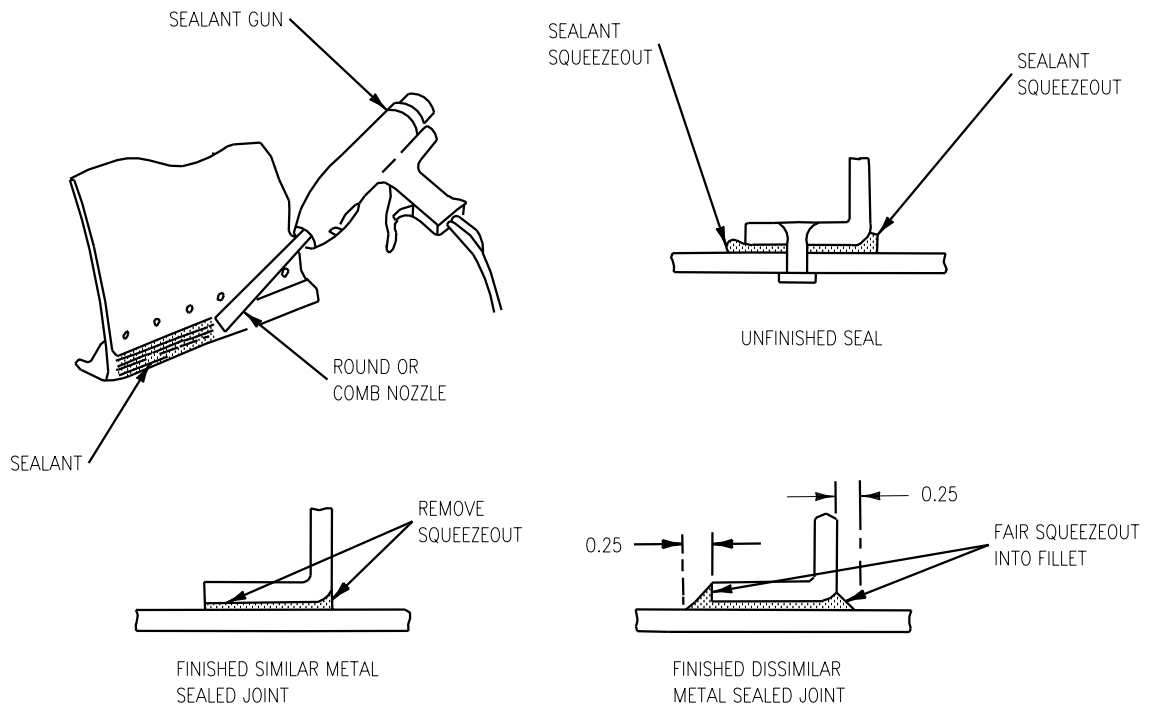
(3) On temperature control assembly (2), set MASTER POWER, CONTROLLER POWER, INDICATOR POWER, TIMER POWER and PRINTER POWER switches to ON.

l. After curing, set all switches to OFF. Allow repair to cool to room temperature.

m. For 74D110165-1001 repair set, disconnect and stow cable assemblies (1), (4), (7), (8),

temperature sensor assembly (5), and heat blanket (6). For 1935AS100-1 repair set (NAVAIR 17-1-131, WP005 00).

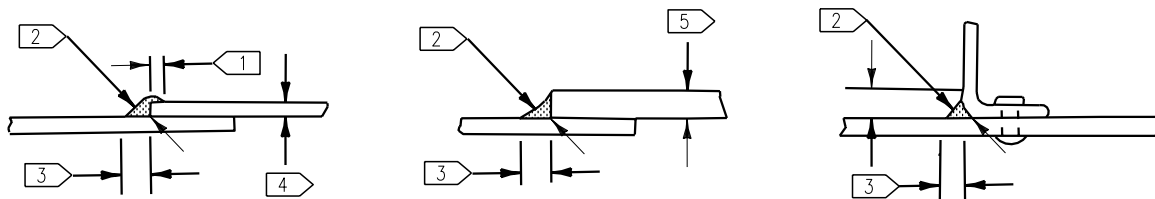
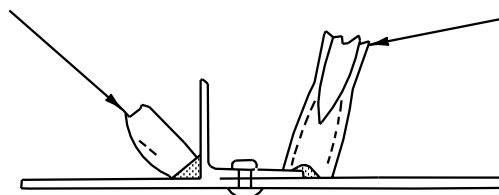
n. Remove layers of satin cloth, copper sheet, teflon cloth, and plastic sheet.



FAY SURFACE SEALING

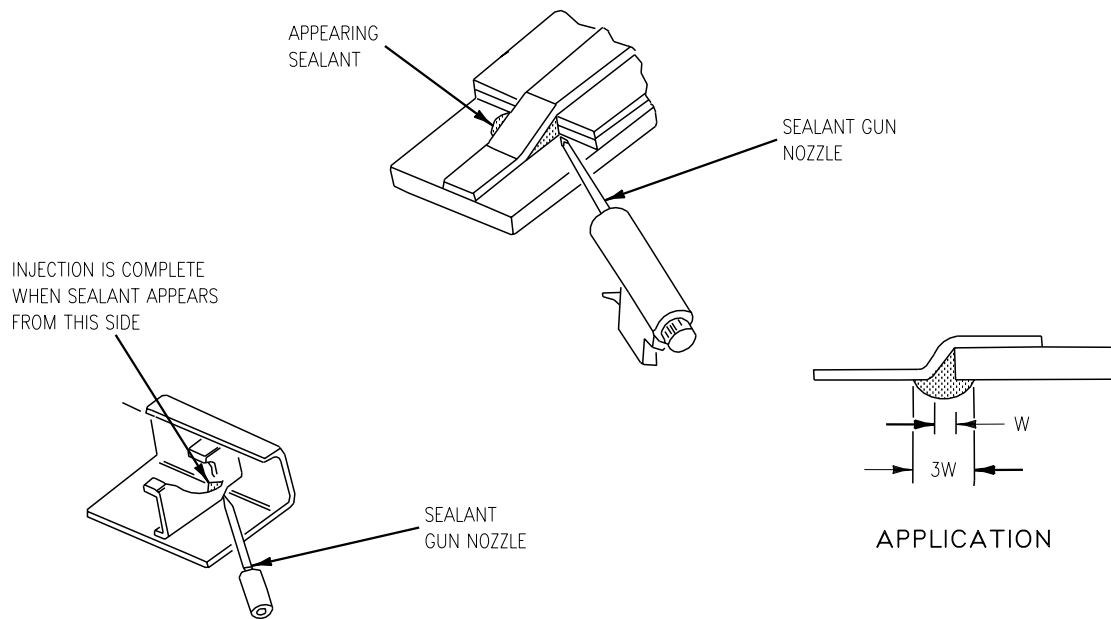
ON MATERIAL GREATER THAN 0.15 THICK USE ROUND SEALANT GUN NOZZLE NO. 420 OR 440.

ON MATERIAL 0.15 THICK OR LESS; FILLET MUST OVERLAP TOP OF MATERIAL. USE SEALANT GUN NOZZLE NO. 8615 (TRIMMED TO CORRECT FILLET CONTOUR).

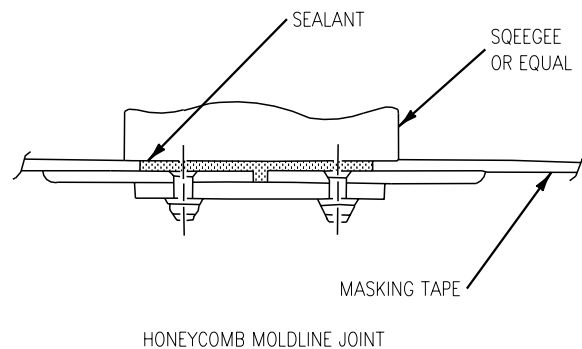
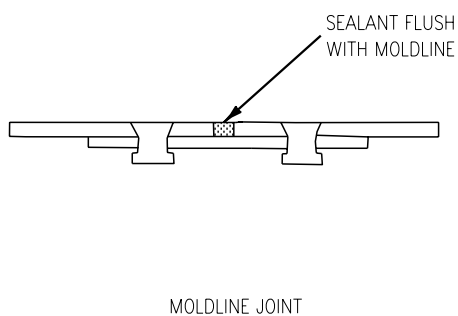
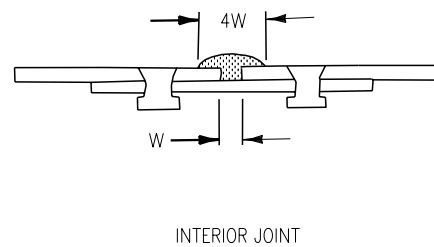
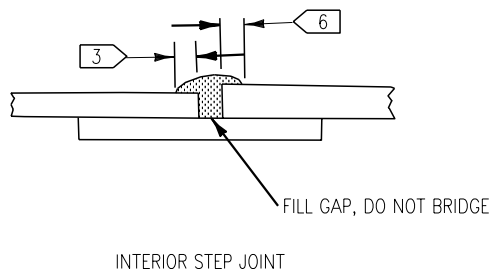


FILLET SEALING

Figure 1. Sealant Joints (Sheet 1)

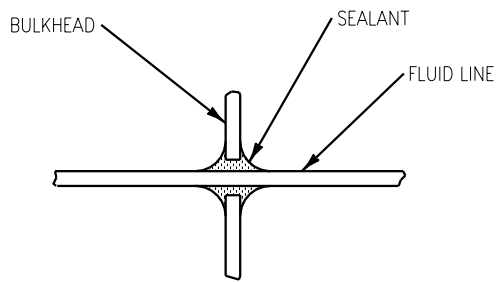


JOGGLE SEALING

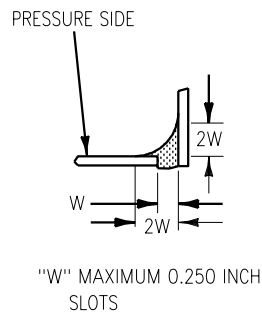


BUTT JOINT SEALING

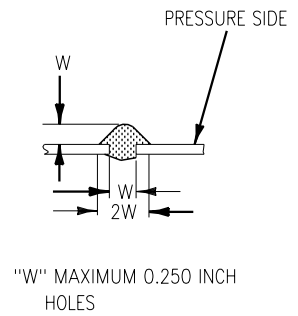
Figure 1. Sealant Joints (Sheet 2)



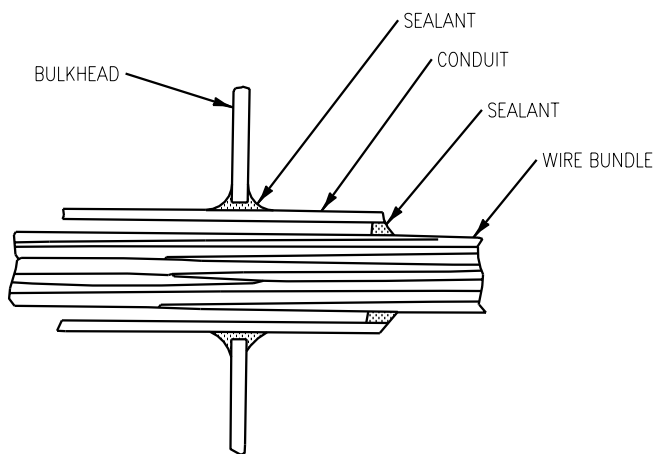
FLUID LINE SEAL



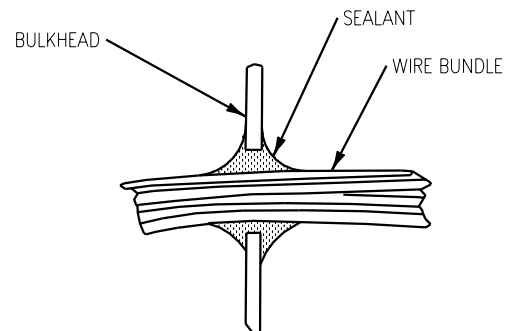
"W" MAXIMUM 0.250 INCH SLOTS



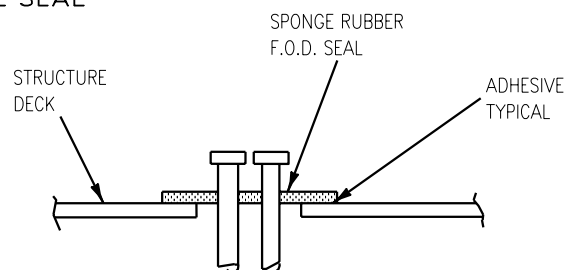
"W" MAXIMUM 0.250 INCH HOLES



CONDUIT WIRE BUNDLE SEAL

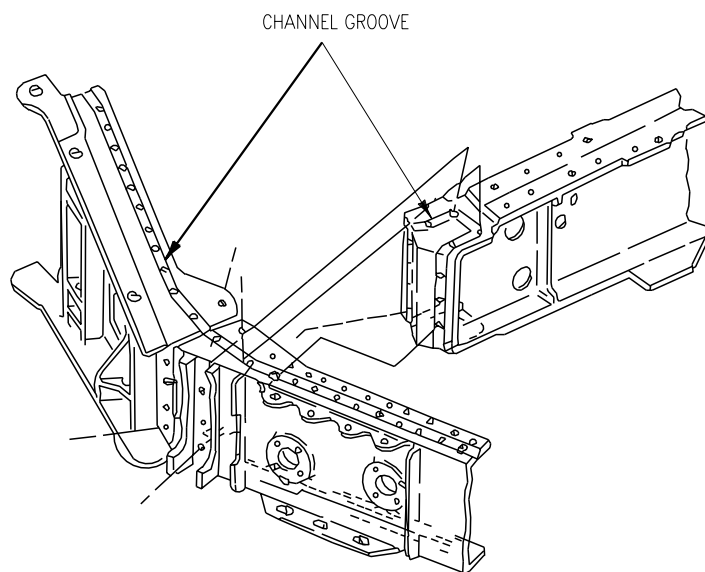
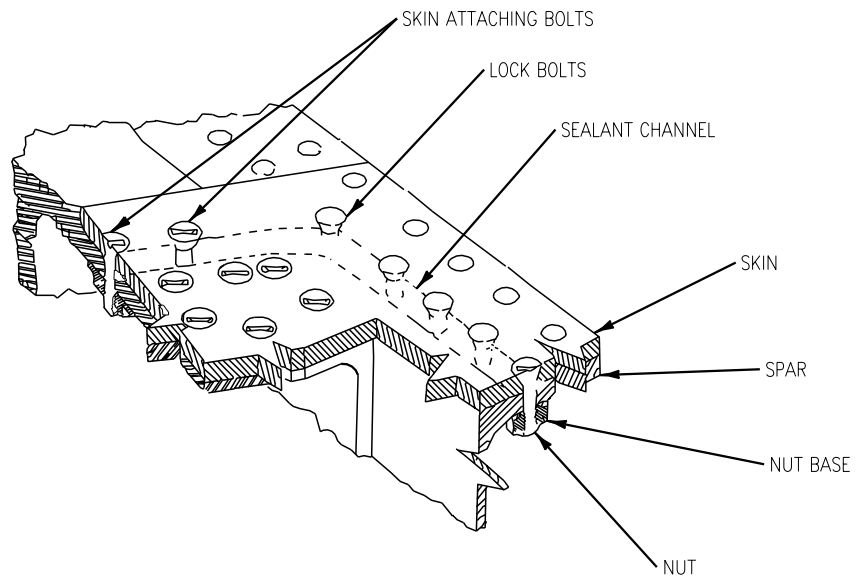


WIRE BUNDLE SEAL



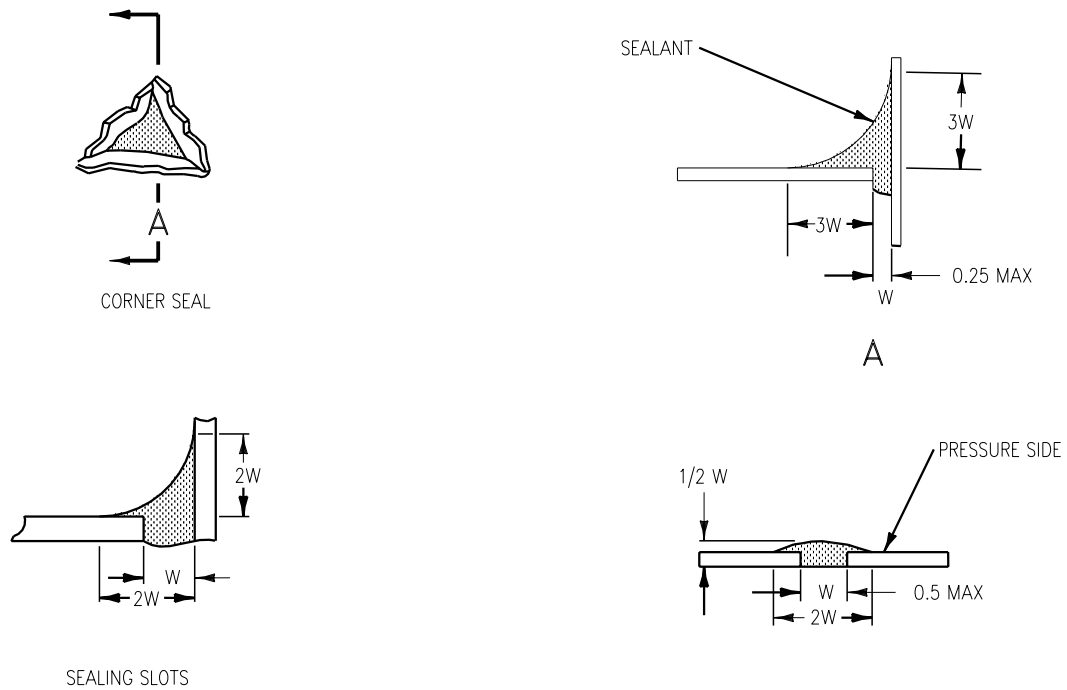
WIRE BUNDLE

Figure 1. Sealant Joints (Sheet 3)



CHANNEL GROOVE SEALING

Figure 1. Sealant Joints (Sheet 4)



VOID SEALING

LEGEND

- 1 FOR METAL TO METAL FILLETS 0.10 TO 0.15 (EQUALS 0 WHEN THICKNESS IS MORE THAN 0.15). FOR GRAPHITE EPOXY TO DISSIMILAR METAL FILLETS 0.15 TO 0.26.
- 2 FOR METAL TO METAL FILLETS 0.10 TO 0.15, FOR GRAPHITE EPOXY TO DISSIMILAR METAL FILLETS 0.15 TO 0.25.
- 3 FOR METAL TO METAL FILLETS 0.15 TO 0.25 FOR GRAPHITE EPOXY TO DISSIMILAR METAL FILLETS 0.20 TO 0.30.
- 4 0.150 OR LESS.
- 5 MORE THAN 0.150.
- 6 FOR METAL TO METAL BUTT JOINT 0.15 TO 0.25, FOR GRAPHITE EPOXY TO DISSIMILAR METAL BUTT JOINT 0.20 TO 0.30.

Figure 1. Sealant Joints (Sheet 5)

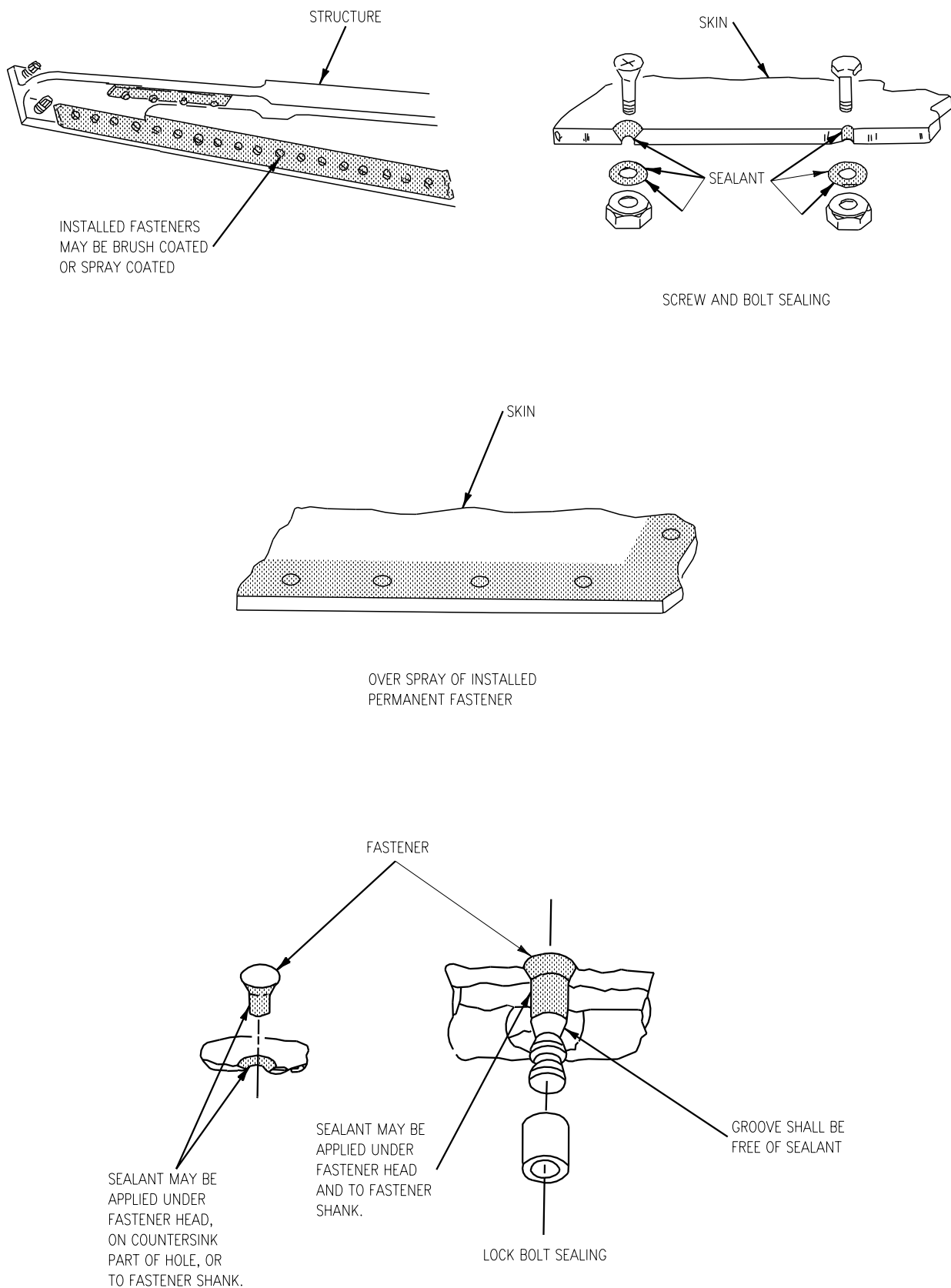
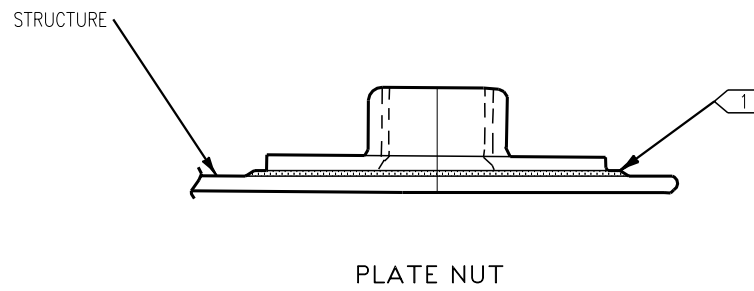
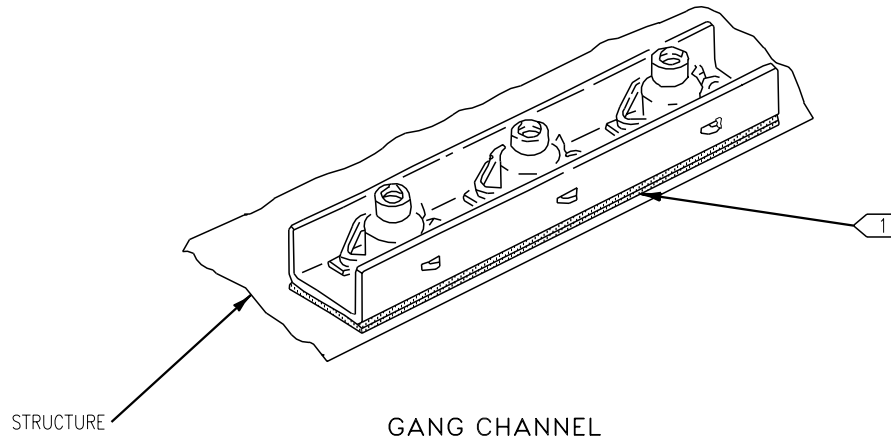


Figure 2. Fastener Sealing



LEGEND


-  SEALANT APPLIED BETWEEN PLATE NUT OR GANG CHANNEL AND STRUCTURE, REFER TO SPECIFIC STRUCTURE REPAIR MANUAL FOR TYPE OF SEALANT.

Figure 3. Gang Channel and Plate Nut Sealing

INTERMEDIATE MAINTENANCE**STRUCTURE REPAIR****SHIPPING CONTAINERS****WING****Reference Material**

Aircraft Weapons Systems Cleaning and Corrosion Control.....	NAVAIR 01-1A-509
Packaging of Material Preservation (Volume 1)	NAVSUP PUB 502
Structure Repair, Wing.....	A1-F18AC-SRM-210
Inner Wing Removal and Installation	WP025 00
Structure Repair, Wing.....	A1-F18AE-SRM-600
Inner Wing Removal and Installation	WP047 00

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Record of Applicable Technical Directives

None

1. DESCRIPTION.

2. Shipping containers in this work package are for returning components to a higher level of maintenance or to cognizant supply activity for disposition. They are not meant for long term storage or adverse shipping conditions. They are to be fabricated using common materials, readily available.

3. GENERAL INFORMATION. See figures 1 through 4.

a. Shipping containers provide protection for components against physical or environmental damage.

b. Shipping containers are constructed of wood or plywood with wood cleats, rub strips, and skids.

c. Interior contour boards are made from wood or plywood with cushioning to protect component. Contour boards secure component inside shipping container and protect component from damage caused by movement.

d. Damaged components may require additional boards to prevent further damage.

e. Loose hardware should be bagged and secured in shipping container.

4. PRESERVATION OF COMPONENTS.

Support Equipment Required

None

Materials Required

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
MIL-L-3150	Lubricating Oil, Preservative Oil
MIL-D-3464 TYPE 1	Desiccant
MIL-B-121 TY1GRA CL1	Barrier Material
MIL-T-22085	Adhesive Tape, Preservation and Sealing Tape
A-A-883, TYPE 1	Pressure Sensitive Tape, Masking Tape

a. Clean foreign material from component before preserving (NAVAIR 01-1A-509 and NAVSUP PUB 502).

b. Painted surfaces require no special coating.

c. Unpainted surfaces, nicks, scratches, or gouges in painted surfaces shall be coated with lubricating oil.

d. All hinges shall be coated with lubricating oil.

e. Put bags of desiccant into cavities and cover cavities with barrier material taped in position with adhesive tape.

5. PROCEDURES.

6. INBOARD LEADING EDGE FLAP SHIPPING CONTAINER.

Support Equipment Required

None

Materials Required

See Figure 1.

7. Fabrication of Shipping Container and Installation of Inboard Leading Edge Flap.

Fabricate shipping container and install inboard leading edge flap as shown in figure 1.

8. OUTBOARD LEADING EDGE FLAP SHIPPING CONTAINER.

Support Equipment Required

None

Materials Required

See Figure 2.

9. Fabrication of Shipping Container and Installation of Outboard Leading Edge Flap.

Fabricate shipping container and install outboard leading edge flap as shown in figure 2.

10. AILERON SHIPPING CONTAINER.

Support Equipment Required

None

Materials Required

See Figure 3.

11. Fabrication of Shipping Container and Installation of Aileron.

Fabricate shipping container and install aileron as shown in figure 3.

12. TRAILING EDGE FLAP SHIPPING CONTAINER.**Support Equipment Required**

None

Materials Required

See Figure 4.

13. Fabrication of Shipping Container and Installation of Trailing Edge Flap. Fabricate shipping container and install trailing edge flap as shown in figure 4 and per procedures below:

a. Fabricate floor section of shipping container.

(1) Nail skids (21) to floor sections (16 and 20).

(2) Nail rub strips (17 and 19) to skids (21).

(3) Attach splice (18) to floor sections (16 and 20) using lag screws (15).

(4) Attach headers (22) to floor sections (16 and 20) using lag screws (15).

(5) Nail contour boards (24) to floor sections (16 and 20).

WARNING

EC847 is highly flammable. Do not use near open flame or sparks. Use only in well ventilated areas.

(6) Glue cushion material (14) to contour boards (24).

b. Attach sides and ends to floor sections.

(1) Attach sides (8 and 9) to skids (21) using lag screws (10).

(2) Attach ends (12) to headers (22) using lag screws (10).

(3) Nail mating surfaces of sides (8 and 9) and ends (12).

c. Carefully lower trailing edge flap into shipping container.

d. Secure trailing edge flap into position.

WARNING

EC847 is highly flammable. Do not use near open flame or sparks. Use only in well ventilated areas.

(1) Glue cushion material (14) to contour board (23).

(2) Position contour boards (23) on trailing edge of part.

(3) Secure contour boards (23), in position, using lag screws (6) and washers (7).

e. Nail top (2 and 26) in position.

14. Trailing Edge Flap Removal From Shipping Container.

a. Remove top (2 and 26) from shipping container.

b. Remove lag screws (6) and washers (7) holding trailing edge flap in position.

c. Remove contour boards (23) and retain.

d. Trailing edge flap is free to remove from shipping container.

15. OUTER WING SHIPPING CONTAINER.**Support Equipment Required**

None

Materials Required

See Figure 5.

16. Fabrication of Shipping Container and Installation of Outer Wing. Fabricate shipping container and install outer wing as shown in figure 5 and per procedures below:

a. Fabricate floor section of shipping container.

(1) Nail skids (9) to floor (32).

(2) Nail rub strips (8) to skids (9).

(3) Attach headers (31) to floor (32) using carriage bolts (30).

(4) Attach floor supports (24) to floor (32) using carriage bolts (30).

(5) Assemble supports (29) and beam (33) using carriage bolts (25).

(6) Attach supports (29) and beam (33) to floor supports (24) using carriage bolts (28).

WARNING

EC847 is highly flammable. Do not use near open flame or sparks. Use only in well ventilated areas.

(7) Glue rubber pad (37) to supports (29) and beam (33) using adhesive (45).

(8) Nail contour boards (39 and 38) to support (29), see detail C.

b. Assemble interior supports for one side, see figure 5.

c. Install outer wing in floor section, see detail C.

d. Assemble interior supports for remaining side and make sure outer wing does not move.

e. Attach sides (7) to skids (9) using lag screws (10).

f. Attach end (13) to headers (31) using lag screws (10).

g. Nail mating edges of sides (7) and ends (13).

h. Nail top joist (18) in position.

i. Nail top (4) in position.

17. Outer Wing Removal From Shipping Container.

a. Remove top (14) from shipping container.

b. Remove top joist (18) from shipping container.

c. Remove lag screws (10) from bottom periphery of shipping container.

d. Remove nails from both ends of one side (7) of shipping container and remove side.

e. Remove remaining side (7) and both ends (13), as one unit, from floor section of shipping container.

f. Remove three threaded steel rods (43) from top support (19) and spacers (14).

g. Remove carriage bolts (23 and 34) from corner post (21) and gussets (44).

WARNING

When removing carriage bolts and end supports, outer wing must be supported to prevent injury to personnel or damage to outer wing.

h. Remove carriage bolts (20) from end supports (23).

i. Remove end supports, as one unit, from one side (7).

j. Remove outer wing from shipping container. Retain all shipping container, supports, and hardware for reuse.

18. INNER WING SHIPPING CONTAINER.

Support Equipment Required

None

Materials Required

See Figure 6.

19. Fabrication of Shipping Container and Installation of Inner Wing. Fabricate shipping container and install inner wing as shown in figure 6 and per procedures below:

a. Assemble floor section per substeps below:

(1) Nail skids (12) to floor sections (34 and 39).

(2) Nail rub strips (7 and 9) to skids (12).

(3) Attach headers (32) to floor sections (34 and 39) using carriage bolts (33).

(4) Attach supports (31) to floor sections (34 and 39) using carriage bolts (33).

(5) Attach braces (18 and 27) to floor sections (34 and 39) using carriage bolts (33).

(6) Attach bottom of one gusset (28) to braces (18 and 27) using carriage bolts (40).

(7) Attach inner lower surface contour board (24) and cleats (20) to filler (38) using carriage bolts (19 and 25).

(8) Nail backup (21) to inner lower surface contour board (24).

(9) Attach inner lower surface contour board (24) to gusset (28) using lag screws (8).

(10) Attach inner lower surface contour (24) to support (31) using carriage bolts (19 and 25).

(11) Attach outer lower surface contour board (30) and cleat (20) to filler (36) using carriage bolts (19 and 25).

(12) Nail backup (29) to outer lower surface contour board (30).

(13) Attach outer lower surface contour board (30) and gusset (28) using lag screws (8).

(14) Attach outer lower surface contour board (30) to support (31) using carriage bolts (19 and 25).

(15) Assemble inner upper surface contour board and outer upper surface contour board and have ready to install when inner wing is positioned in shipping container.

WARNING

Adhesive is highly flammable. Do not use near open flame or sparks. Use only in well ventilated areas.

(16) Install cushion material (22) using adhesive (23).

(17) Position inner wing in shipping container using sling (A1-F18AC-SRM-210, WP025 00 or A1-F18AE-SRM-600, WP047 00).

(18) Attach tie support (26) to inner and outer lower surface contour boards (24 and 30) using carriage bolts (25).

(19) Remove adapter and sling and manually hold inner wing against installed inner and outer lower surface contour.

(20) Attach bottom of gusset (28) to braces (18 and 27) using carriage bolts (40).

(21) Attach assembled inner and outer upper surface contour boards (35 and 38) to gusset (28) using carriage bolts (25).

(22) Attach inner and outer upper surface contour boards (35 and 37) to supports (31) using carriage bolts (19 and 25).

NOTE

Hardware shall remain loose until enough cushion material is in position to keep inner wing from moving in shipping container.

(23) Attach tie supports (26) to inner and outer upper surface contour boards (35 and 37) using carriage bolts (19) and make sure enough cushion material is in position to hold inner wing tightly.

(24) Make final inspection of all hardware to make sure of security of inner wing.

b. Attach sides (6 and 10) and ends (16) to shipping container floor section per figure 6 and as below:

(1) Attach ends (16) to headers (32) using lag screws (8).

(2) Attach sides (6 and 10) to skids (12) using lag screws (8).

(3) Nail mating surface of sides (6 and 10) and ends (16).

(4) Nail top (2 and 5) in position.

20. Inner Wing Removal from Shipping Container.

a. Remove top (2 and 5) from shipping container.

b. Remove lag screws (8) from bottom periphery of shipping container.

c. Carefully remove nails from both ends (16) of one side (6 and 10) of shipping container and remove side.

d. Remove second side (6 or 10) and attached ends (16) as one unit.

e. Remove carriage bolts (25) from both ends of tie supports (26) and remove tie supports.

f. Remove carriage bolts (19 and 25) holding inner and outer upper surface contour boards (35) and (37) to supports (31).

WARNING

When removing lag screws from gusset and inner and outer upper surface contour boards inner wing must be supported to prevent injury to personnel or damage to inner wing.

g. While manually holding inner wing in position, remove lag screws (8) holding gusset (28)

to inner and outer upper surface contour boards (35 and 37).

h. Remove carriage bolts (40) holding gusset (28) to braces (18 and 27).

i. Inner wing is now free to be removed from shipping container using sling (A1-F18AC-SRM-210, WP025 00 or A1-F18AE-SRM-600, WP047 00).

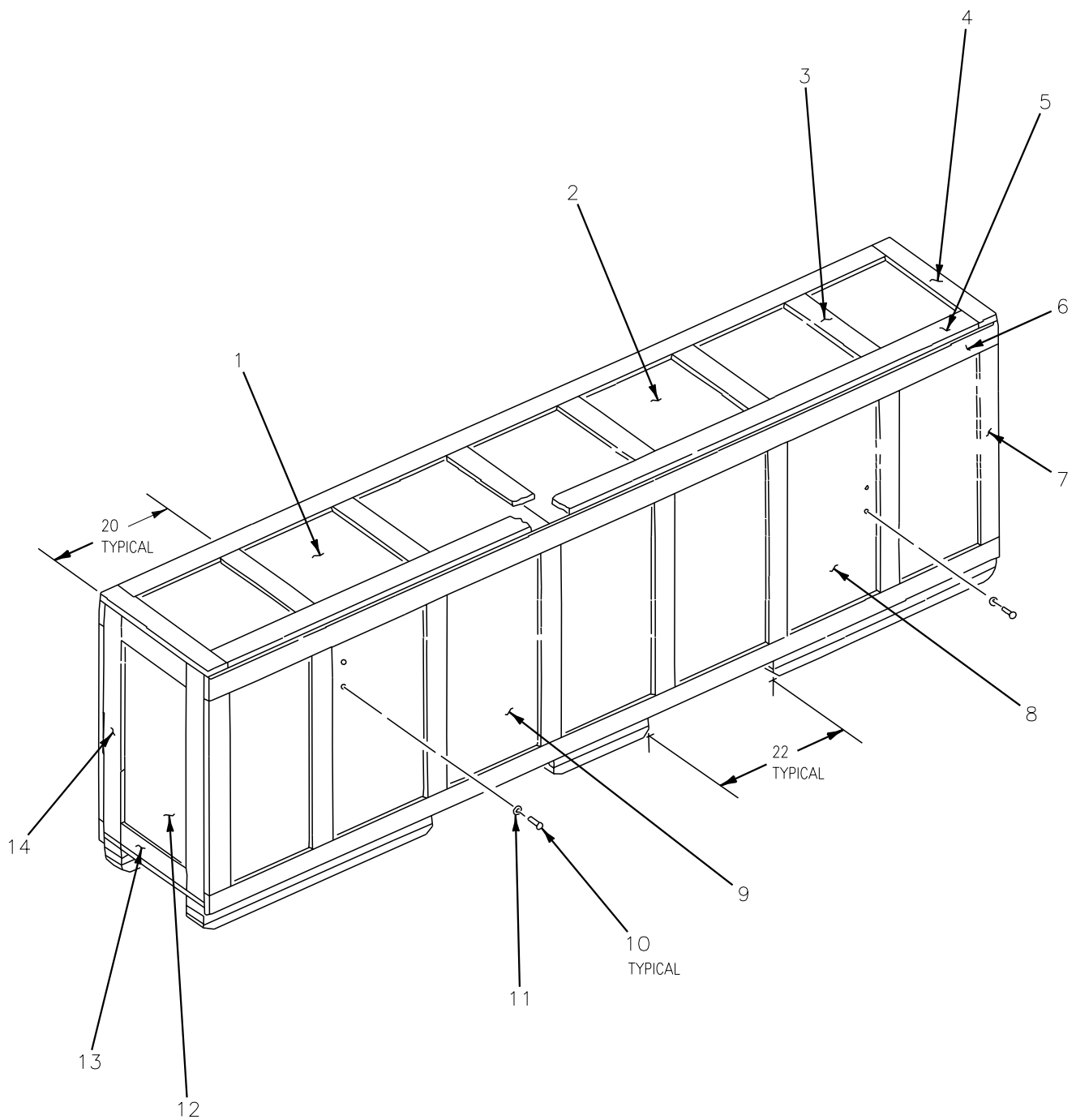


Figure 1. Inboard Leading Edge Flap Shipping Container (Sheet 1)

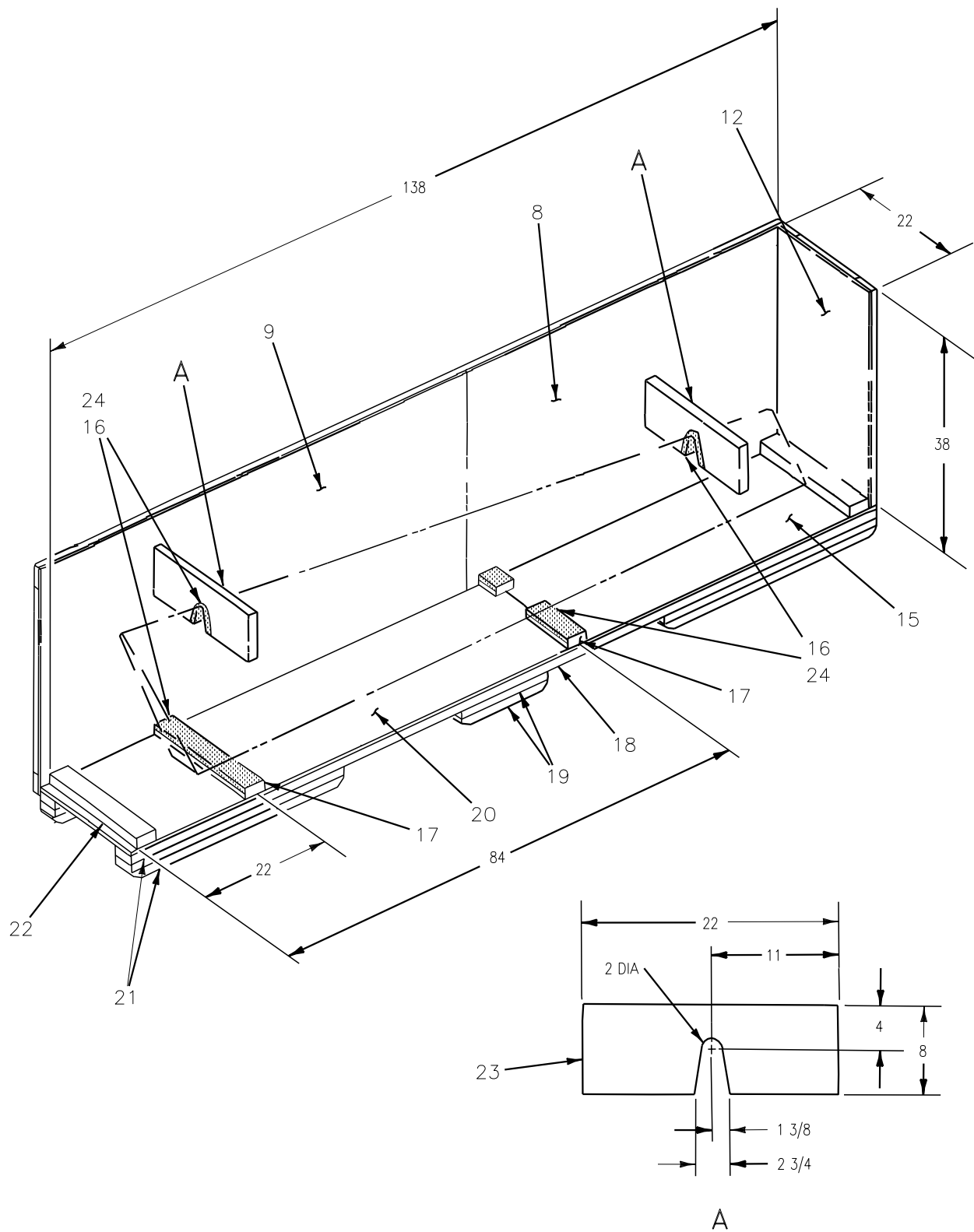


Figure 1. Inboard Leading Edge Flap Shipping Container (Sheet 2)

BILL OF MATERIALS				
INDEX	QTY	NOMENCLATURE	SIZE	REMARKS
1	1	TOP, SHEATHING	1/4 X 24 X 60	
2	1	TOP, SHEATHING	1/4 X 24 X 80	
3	6	CLEAT	1 X 4 X 17	
4	2	CLEAT	1 X 4 X 24	
5	2	CLEAT	1 X 4 X 133	
6	4	CLEAT	1 X 4 X 140	
7	16	CLEAT	1 X 4 X 39 1/2	
8	2	SIDE, SHEATHING	1/4 X 39 1/2 X 60	
9	2	SIDE, SHEATHING	1/4 X 39 1/2 X 80	
10	8	LAG SCREW	1/2 X 2	2
11	8	WASHER	1/2	
12	2	END, SHEATHING	1/4 X 22 X 38	
13	4	CLEAT	1 X 4 X 15	
14	4	CLEAT	1 X 4 X 38	
15	1	FLOOR, SHEATHING	3/4 X 22 X 56	
16	A/R	CUSHION MATERIAL	AS REQUIRED	3
17	2	SUPPORT	2 X 4 X 22	
18	2	SKID	2 X 4 X 140	
19	4	RUB STRIP	2 X 4 X 16	
20	1	FLOOR, SHEATHING	3/4 X 22 X 84	
21	8	RUB STRIP	2 X 4 X 40	
22	2	HEADER	2 X 4 X 22	
23	2	CONTOUR	2 X 8 X 22	
24	A/R	EC-847 ADHESIVE	AS REQUIRED	3

LEGEND

1. INBOARD LEADING EDGE FLAP WEIGHT IS 88 POUNDS AND GROSS WEIGHT OF SHIPPING CONTAINER AND INBOARD LEADING EDGE FLAP IS APPROXIMATELY 495 POUNDS.

2 USE 3/16-INCH TWIST DRILL TO MAKE PILOT HOLES.

3 CUSHION MATERIAL, POLYETHYLENE, PPP-C-1752, GLUED INTO POSITION WITH EC-847 ADHESIVE.

Figure 1. Inboard Leading Edge Flap Shipping Container (Sheet 3)

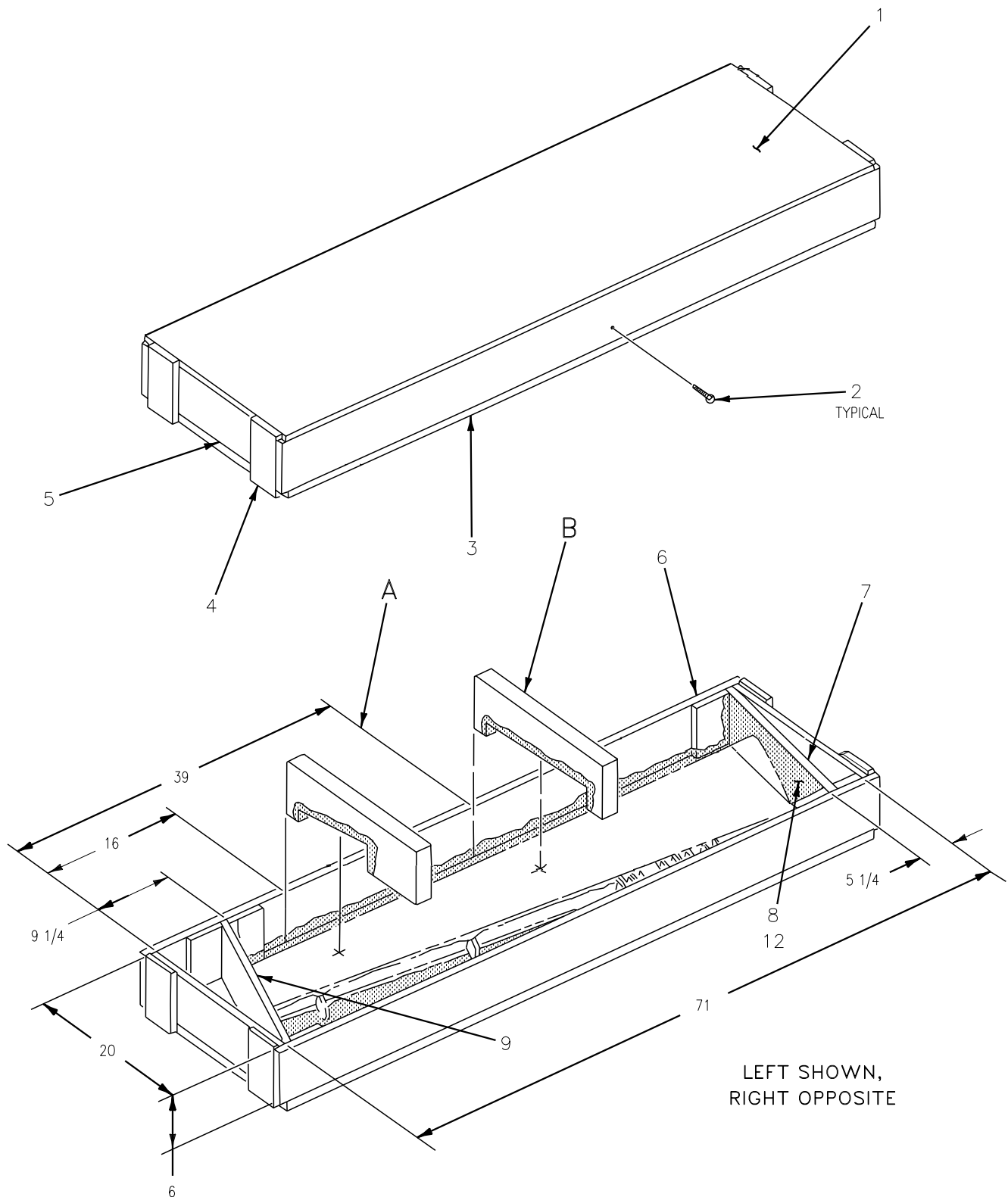
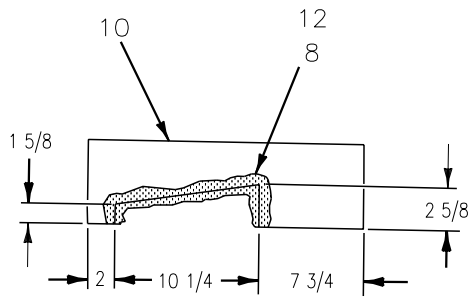
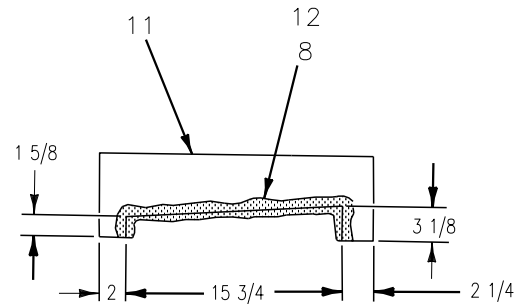


Figure 2. Outboard Leading Edge Flap Shipping Container (Sheet 1)



A



B

BILL OF MATERIALS				
ITEM	QTY	NOMENCLATURE	SIZE	REMARKS
1	2	TOP AND BOTTOM, SHEATHING	3/4 X 22 X 73	
2	8	LAG SCREW	1/2 X 3	2
3	2	SIDE, SHEATHING	1 X 6 X 74	
4	4	CLEAT	1 X 4 X 7	
5	2	END, SHEATHING	1 X 6 X 20	
6	6	CLEAT	1 X 6 X 4	
7	1	CONTOUR	1 X 6 X 20 1/2	
8	A/R	CUSHION MATERIAL	AS REQUIRED	3
9	1	CONTOUR	1 X 6 X 20 3/4	
10	1	CONTOUR	2 X 6 X 20	
11	1	CONTOUR	2 X 6 X 20	
12	A/R	EC-847 ADHESIVE	AS REQUIRED	3

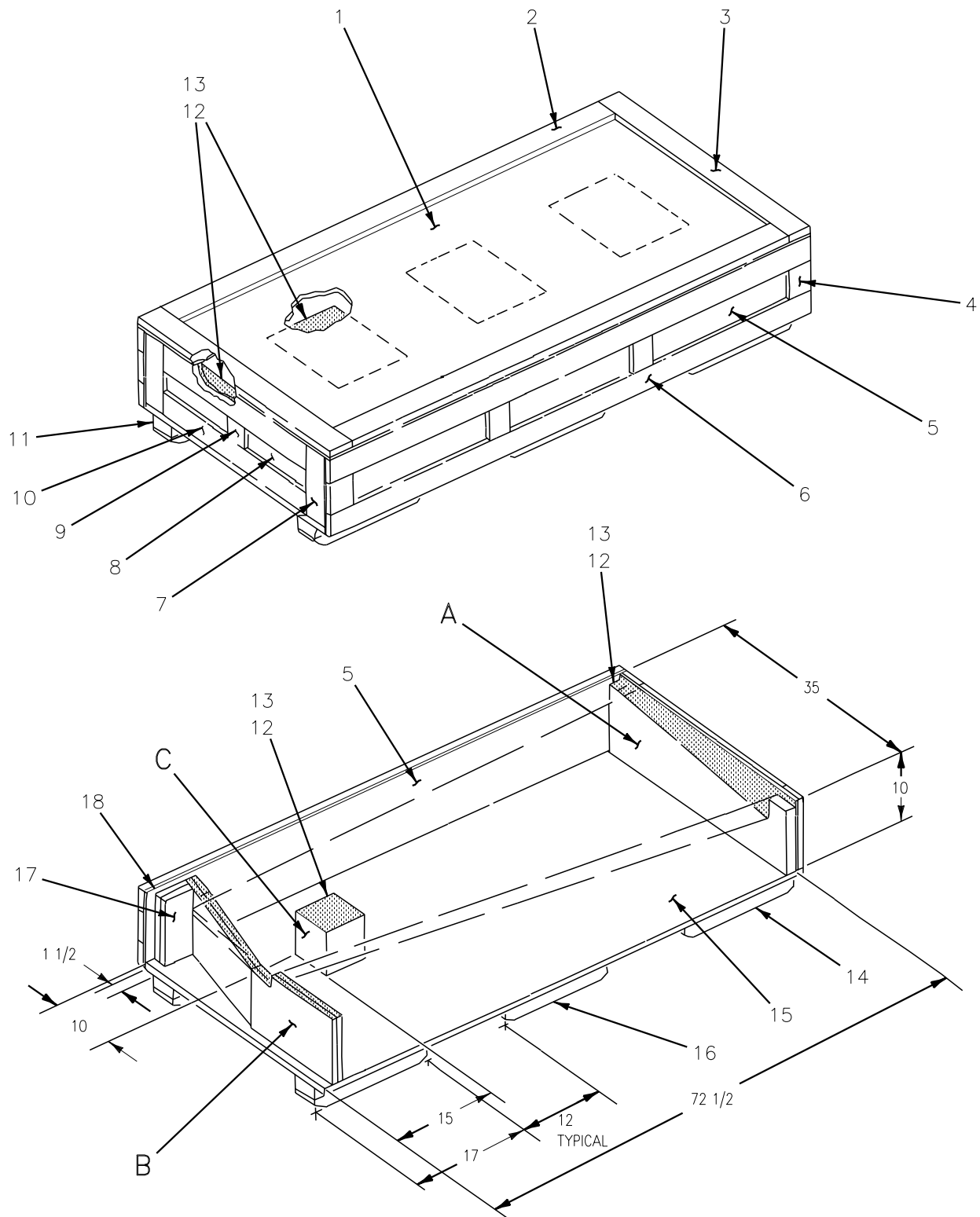
LEGEND

1. OUTBOARD LEADING EDGE FLAP WEIGHT IS 25 POUNDS AND GROSS WEIGHT OF SHIPPING CONTAINER AND OUTBOARD LEADING EDGE FLAP IS APPROXIMATELY 65 POUNDS.

2 USE 3/8-INCH TWIST DRILL TO MAKE PILOT HOLES.

3 CUSHION MATERIAL, POLYETHELENE, PPP-C-1752, GLUED INTO POSITION WITH EC-847 ADHESIVE.

Figure 2. Outboard Leading Edge Flap Shipping Container (Sheet 2)



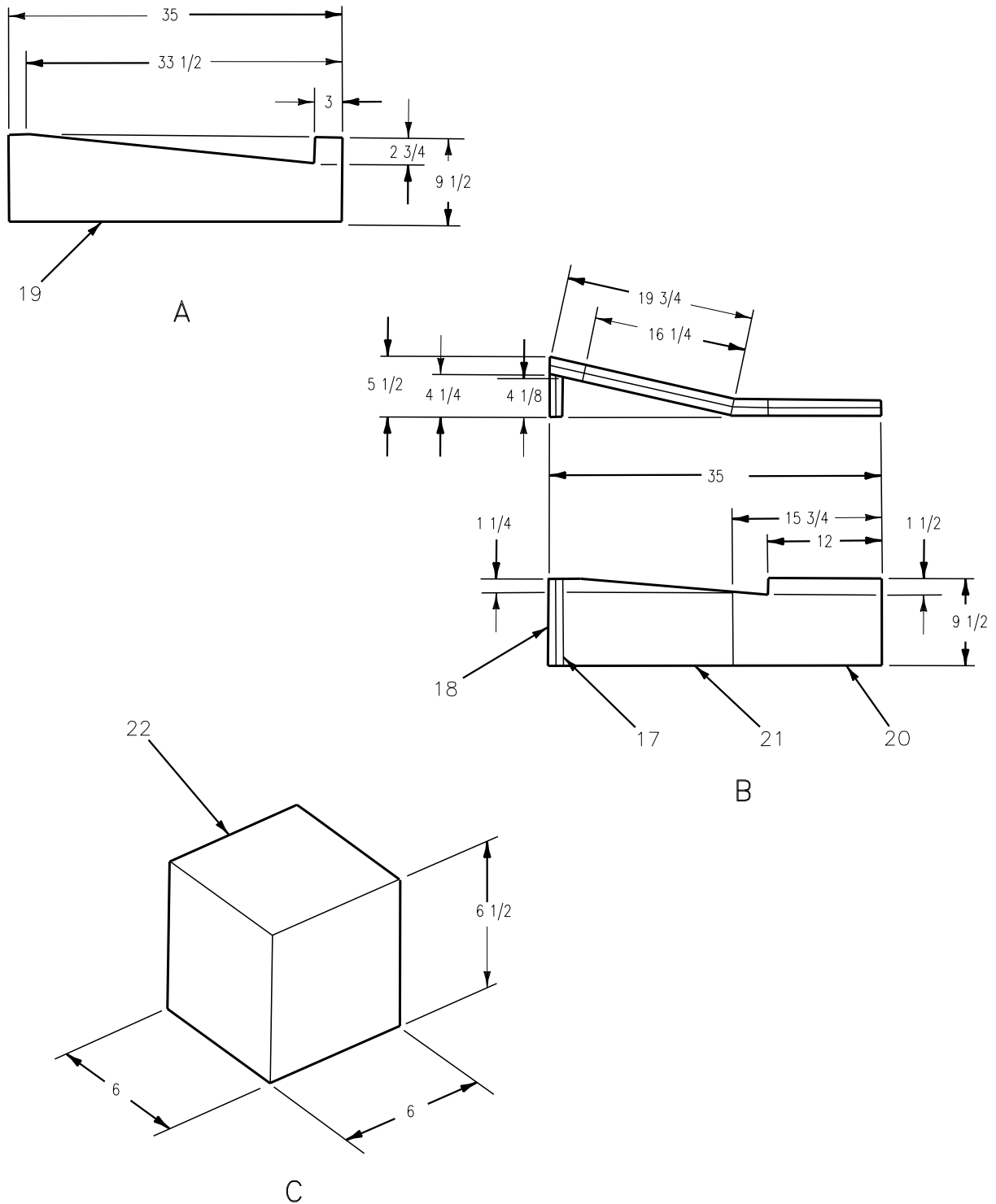


Figure 3. Aileron Shipping Container (Sheet 2)

BILL OF MATERIALS				
INDEX	QTY	NOMENCLATURE	SIZE	REMARKS
1	1	TOP, SHEATHING	1/4 X 37 X 74 1/2	
2	2	CLEAT	1 X 4 X 67 1/2	
3	2	CLEAT	1 X 4 X 37	
4	8	CLEAT	1 X 4 X 4	
5	2	SIDE, SHEATHING	1/4 X 11 X 74 1/2	
6	4	CLEAT	1 X 4 X 74 1/2	
7	4	CLEAT	1 X 4 X 10	
8	2	END, SHEATHING	1/4 X 10 X 35	
9	2	CLEAT	1 X 4 X 3	
10	4	CLEAT	1 X 4 X 28	
11	2	SKID	2 X 4 X 74 1/2	
12	A/R	CUSHION MATERIAL	AS REQUIRED	2
13	A/R	EC-847 ADHESIVE	AS REQUIRED	2
14	4	RUB STRIP	2 X 4 X 17	
15	1	FLOOR, SHEATHING	1 X 35 X 74 1/2	
16	2	RUB STRIP	2 X 4 16	
17	1	SUPPORT, SHEATHING	3/4 X 4 1/8 X 9 1/2	
18	1	SUPPORT, SHEATHING	3/4 X 4 1/4 X 9 1/2	
19	1	CONTOUR, SHEATHING	2 X 9 1/2 X 35	
20	2	CONTOUR, SHEATHING	1 X 9 1/2 X 15 3/4	3
21	2	CONTOUR, SHEATHING	1 X 9 1/2 X 19 3/4	3
22	1	SUPPORT	6 X 6 X 6 1/2	

LEGEND

1. AILERON WEIGHT IS 30 POUNDS AND GROSS WEIGHT OF SHIPPING CONTAINER AND AILERON IS APPROXIMATELY 145 POUNDS.

2 CUSHION MATERIAL, POLYETHYLENE, PPP-C-1752, GLUED INTO POSITION WITH EC-847 ADHESIVE.

3 MAKE CUT AT 15 3/4 INCHES. MAKE SECOND CUT TO ALL 4 PIECES AT 20° ANGLE, SEE DETAIL B.

Figure 3. Aileron Shipping Container (Sheet 3)

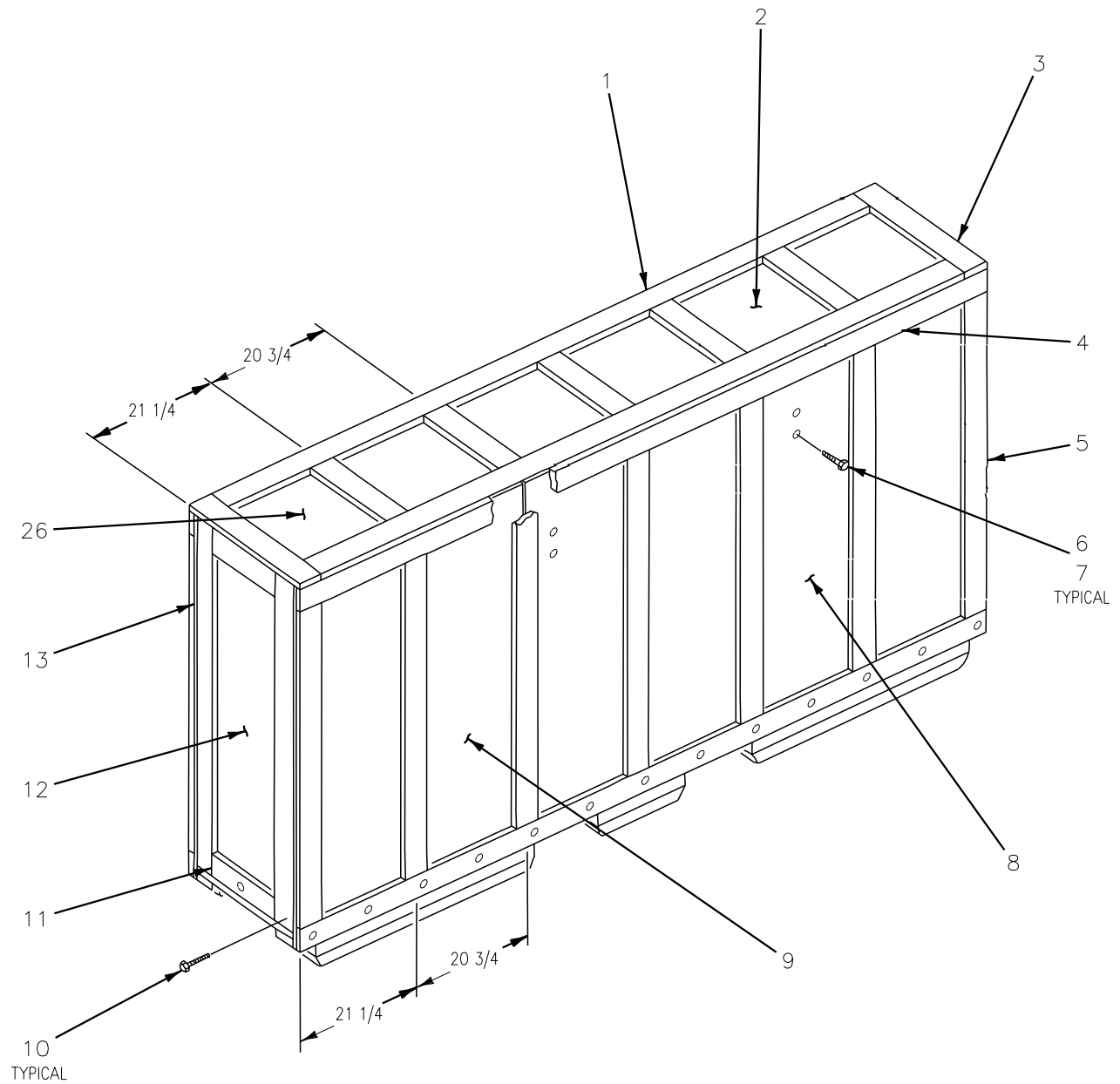


Figure 4. Trailing Edge Flap Shipping Container (Sheet 1)

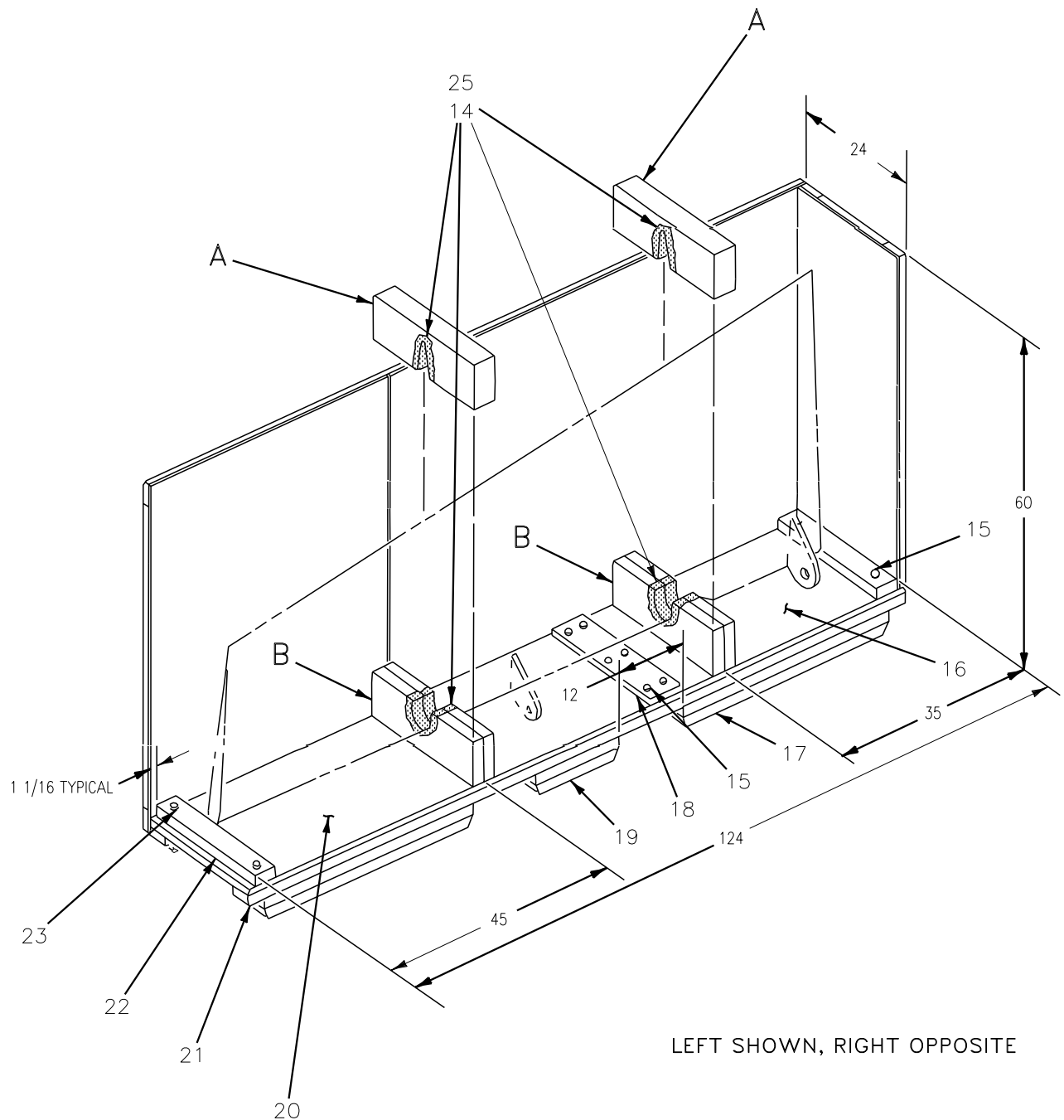
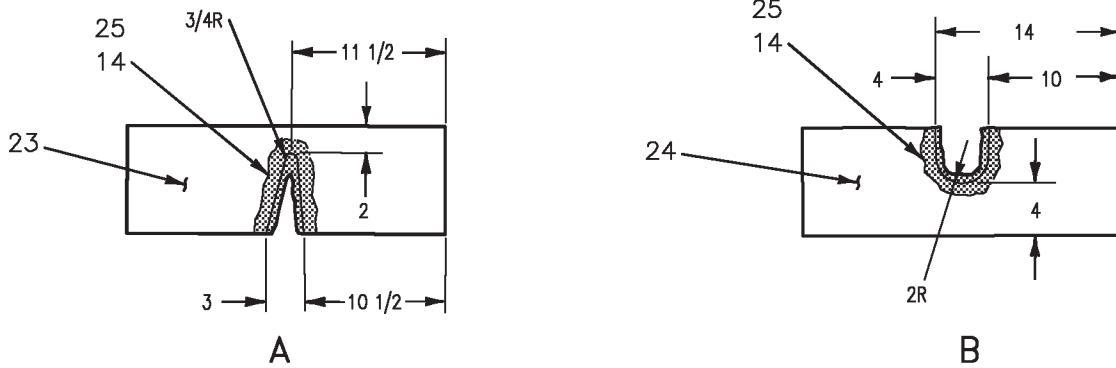


Figure 4. Trailing Edge Flap Shipping Container (Sheet 2)



18AC-SRM-20-(97-3)31-SCAN

BILL OF MATERIALS				
INDEX	QTY	NOMENCLATURE	SIZE	REMARKS
1	2	CLEAT	1 X 4 X 119	
2	2	TOP, SHEATHING	1/4 X 26 X 80	
3	2	CLEAT	1 X 4 X 26	
4	4	CLEAT	1 X 4 X 126	
5	14	CLEAT	1 X 4 X 55 1/2	
6	8	LAG SCREW	1/2 X 2	2
7	8	WASHER	1/2	
8	2	SIDE, SHEATHING	1/4 X 62 1/2 X 80	
9	2	SIDE, SHEATHING	1/4 X 46 X 62 1/2	
10	32	LAG SCREW	1/2 X 3	
11	4	CLEAT	1 X 4 X 17	
12	2	END, SHEATHING	1/4 X 24 X 60	2
13	4	CLEAT	1 X 4 X 60	
14	A/R	CUSHION MATERIAL	AS REQUIRED	3
15	10	LAG SCREW	1/2 X 4	2
16	1	FLOOR, SHEATHING	1 X 24 X 46	
17	8	RUB STRIP	2 X 4 X 40	
18	1	SPLICE, SHEATHING	1 X 6 X 24	
19	4	RUB STRIP	2 X 4 X 16	
20	1	FLOOR, SHEATHING	1 X 24 X 80	
21	2	SKID	2 X 4 X 126	
22	2	HEADER	2 X 4 X 24	
23	2	CONTOUR BOARD	2 X 8 X 24	
24	4	CONTOUR BOARD	2 X 8 X 24	
25	A/R	EC-847 ADHESIVE	AS REQUIRED	
26	1	TOP, SHEATHING	1 X 26 X 46	

LEGEND

1. TRAILING EDGE FLAP WEIGHT IS 101 POUNDS AND GROSS WEIGHT OF SHIPPING CONTAINER AND TRAILING EDGE FLAP IS APPROXIMATELY 350 POUNDS.

2 USE 3/8-INCH TWIST DRILL TO MAKE PILOT HOLES.

3 CUSHION MATERIAL, POLYETHYLENE, PPP-C-1752, GLUED INTO POSITION WITH EC-847 ADHESIVE.

Figure 4. Trailing Edge Flap Shipping Container (Sheet 3)

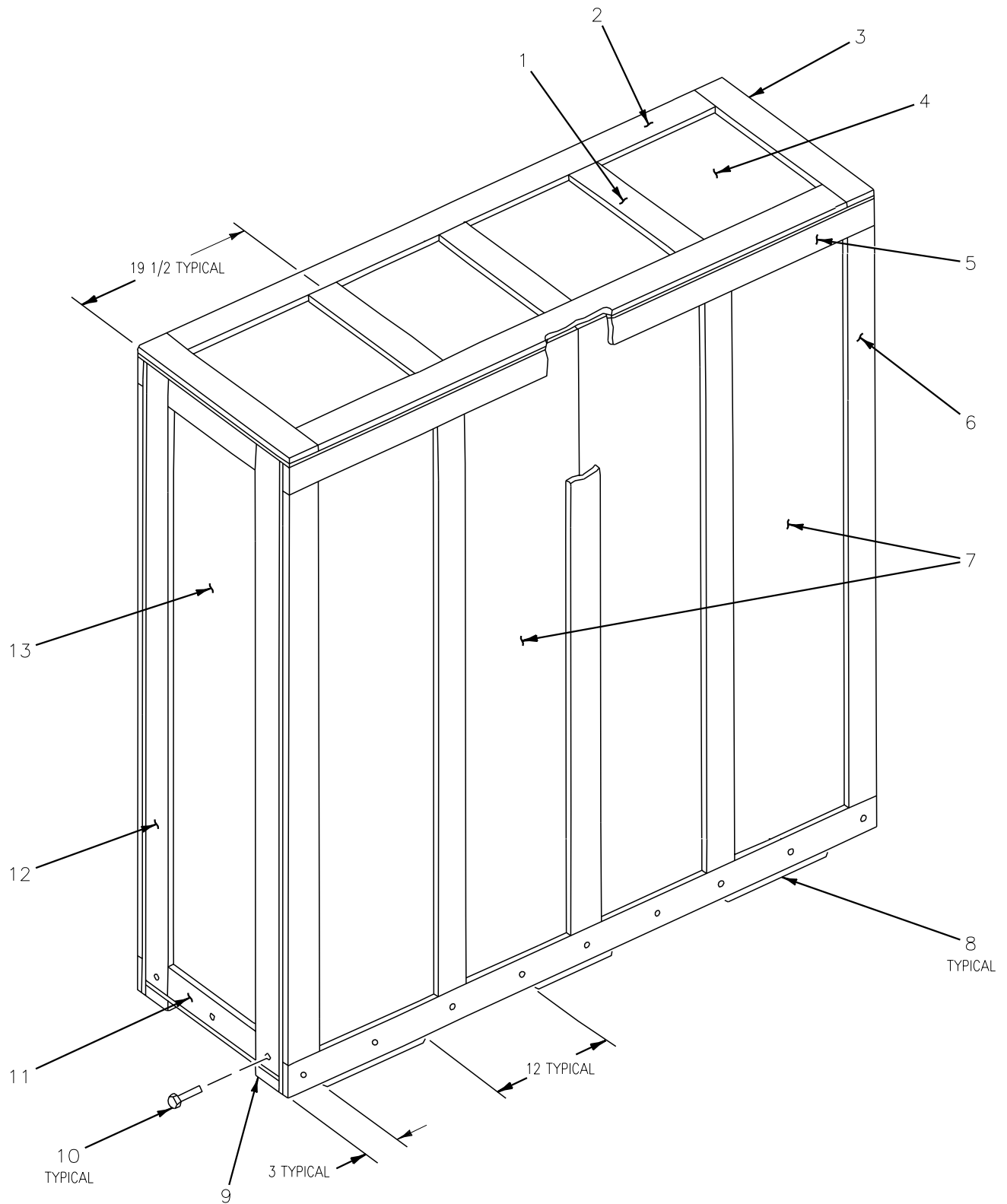


Figure 5. Outer Wing Shipping Container (Sheet 1)

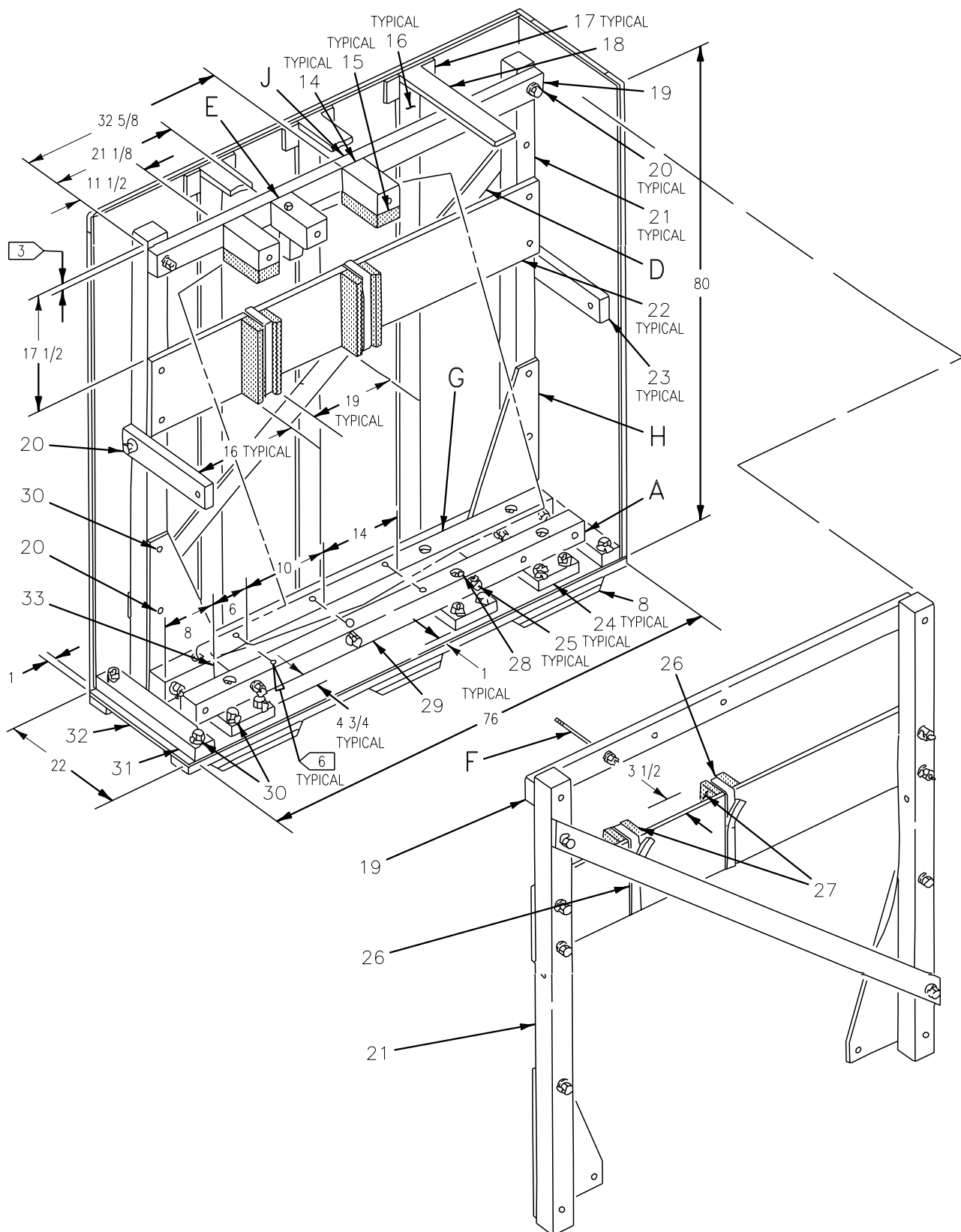


Figure 5. Outer Wing Shipping Container (Sheet 2)

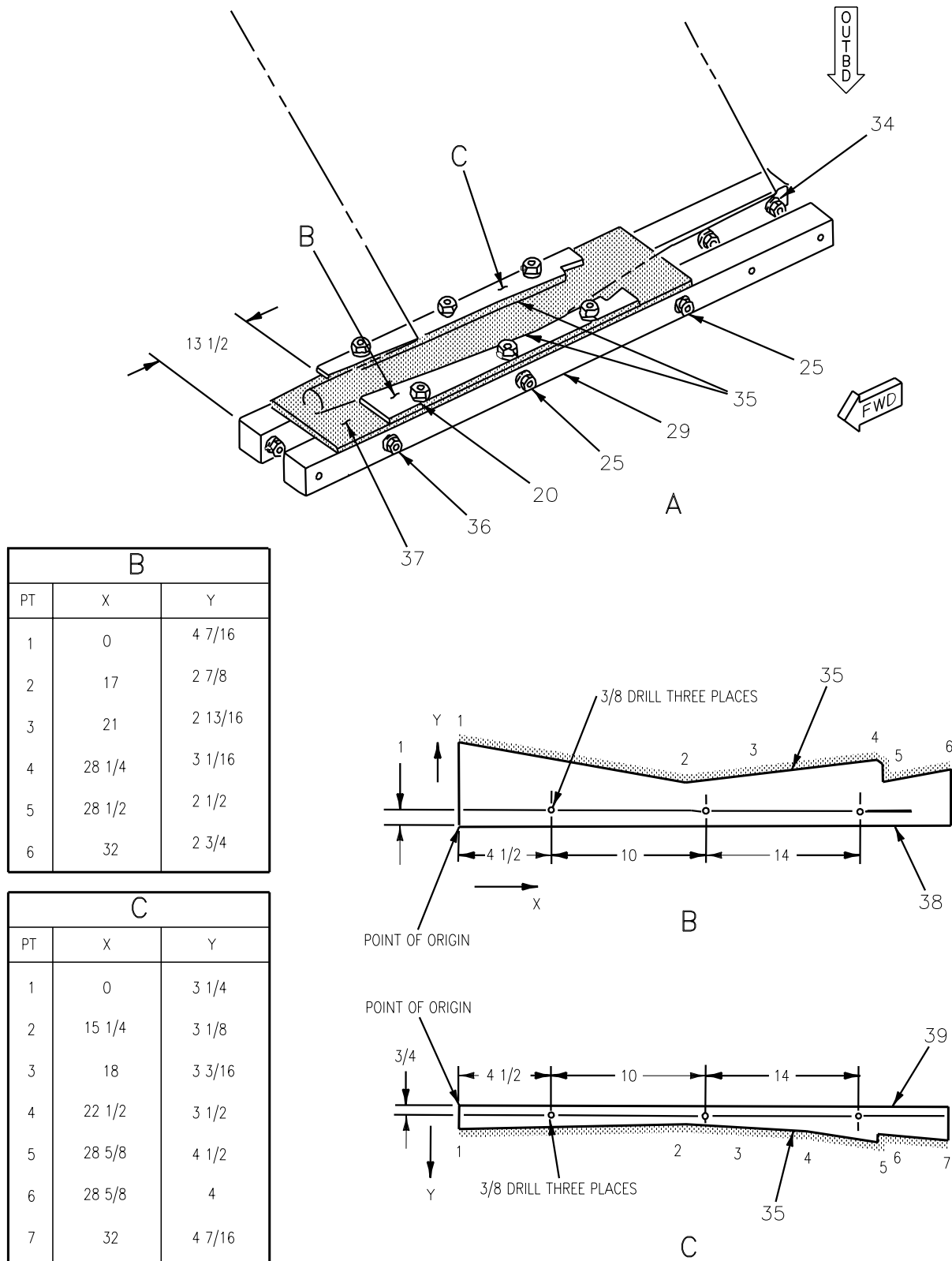


Figure 5. Outer Wing Shipping Container (Sheet 3)

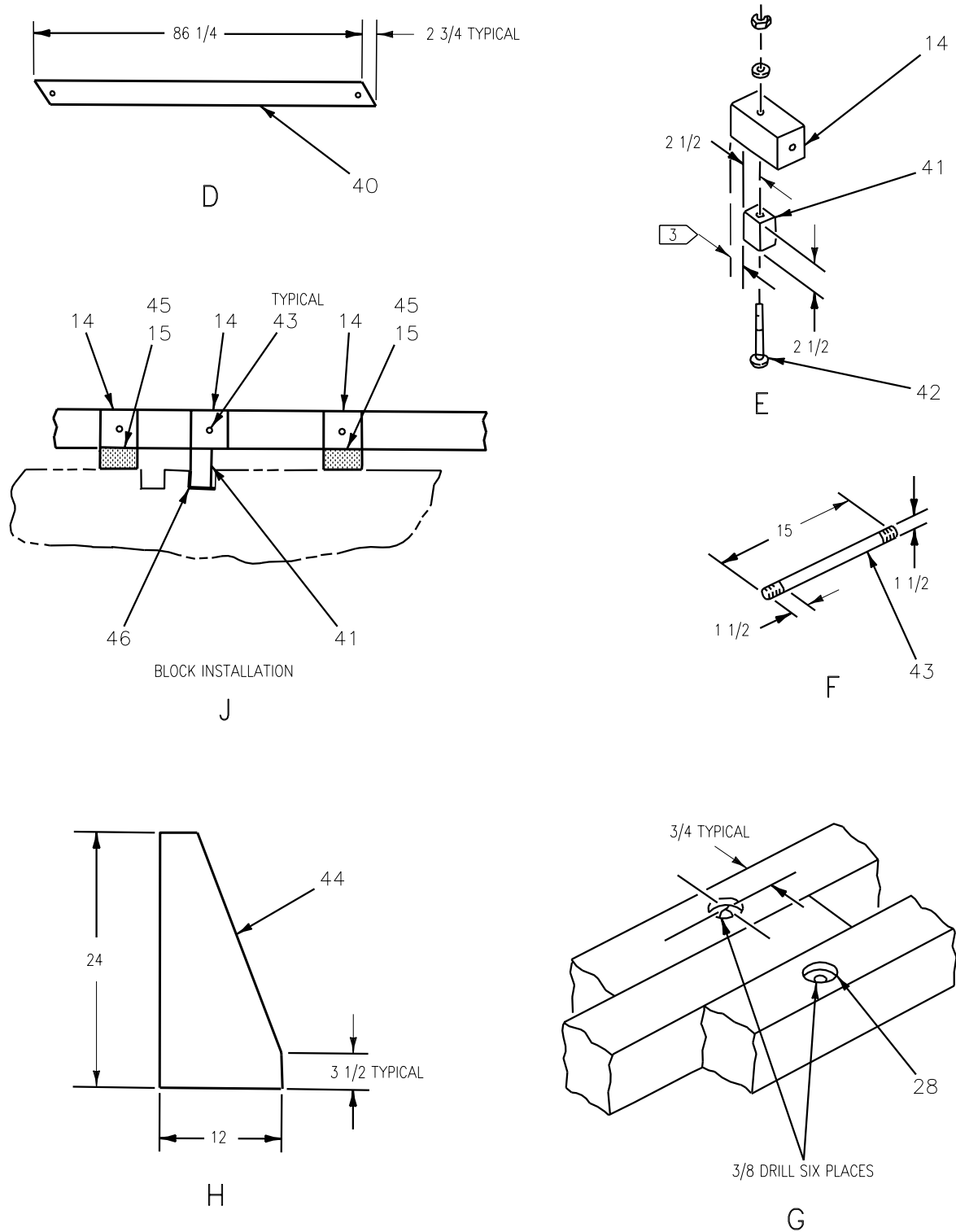


Figure 5. Outer Wing Shipping Container (Sheet 4)

BILL OF MATERIALS				
INDEX	QTY	NOMENCLATURE	SIZE	REMARKS
1	3	CLEAT	1 X 4 X 19	
2	2	CLEAT	1 X 4 X 73	
3	2	CLEAT	1 X 4 X 26	
4	1	TOP, SHEATHING	1/4 X 24 X 78	
5	4	CLEAT	1 X 4 X 78	
6	10	CLEAT	1 X 4 X 75	
7	4	SIDE, SHEATHING	1/4 X 38 X 82	
8	12	RUB, STRIP	2 X 4 X 16	
9	2	SKID	2 X 4 X 78	
10	24	LAG SCREW	3/8 X 3	2
11	4	CLEAT	1 X 4 X 17	
12	4	CLEAT	1 X 4 X 80	
13	2	END, SHEATHING	1/4 X 22 X 80	
14	3	SPACER	4 X 4 X 8 1/2	
15	2	CUSHION, MATERIAL	2 X 3 1/2 X 8 1/2	4
16	6	JOIST	1 X 4 X 79 1/4	
17	12	JOIST SUPPORT	1 X 4 X 4	
18	3	TOP JOIST	1 X 4 X 22	
19	2	TOP SUPPORT	2 X 4 X 68	
20	10	CARRIAGE BOLT AND HARDWARE	3/8 X 6	
21	4	CORNER POST	4 X 4 X 72 1/2	
22	2	BACKUP, SHEATHING	1/2 X 12 X 68	
23	2	END SUPPORT	2 X 4 X 18 1/2	
24	3	FLOOR SUPPORT	2 X 6 X 20	
25	2	CARRIAGE BOLT AND HARDWARE	1/2 X 12	
26	2	COTTON WEBBING	1 INCH WIDE	
27	2	CUSHION MATERIAL	3 1/2 X 4 X 12	4
28	6	CARRIAGE BOLT AND HARDWARE	1/2 X 6	COUNTERSINK HOLES
29	2	SUPPORT	4 X 4 X 68	
30	20	CARRIAGE BOLT AND HARDWARE	1/2 X 4 1/2	
31	2	HEADER	2 X 4 X 22	
32	1	FLOOR, SHEATHING	1/2 X 22 X 76	
33	1	BEAM	4 X 4 X 42	
34	6	CARRIAGE BOLT AND HARDWARE	1/2 X 8	
35	2	RUBBER PAD	1/8 X 1 1/2 X 32	5
36	1	CARRIAGE BOLT AND HARDWARE	1/2 X 13	
37	1	RUBBER PAD	1/4 X 10 X 42	5
38	1	CONTOUR BOARD	2 X 4 7/16 X 32	
39	1	CONTOUR BOARD	2 X 4 1/2 X 32	
40	2	CROSS SUPPORT	1 X 4 X 89	
41	1	LOCATOR	2 1/4 X 2 1/2 X 2 1/2	
42	1	CARRIAGE BOLT AND HARDWARE	1/2 X 7	COUNTERSINK HEAD
43	3	THREADED STEEL ROD AND HARDWARE	1/2 X 15	
44	4	GUSSET	1/2 X 12 X 24	
45	A/R	EC-847 ADHESIVE	AS REQUIRED	
46	A/R	CUSHION MATERIAL	AS REQUIRED	

LEGEND

1. WEIGHT OF OUTER WING IS 200 POUNDS AND GROSS WEIGHT OF SHIPPING CONTAINER AND OUTER WING IS APPROXIMATELY 400 POUNDS.

2 USE 3/16-INCH TWIST DRILL TO MAKE PILOT HOLES.

3 LOCATE AND DRILL DURING ASSEMBLY TO MAKE SURE OF CORRECT FIT.

4 CUSHION MATERIAL, POLYETHYLENE, PPP-C-1752, GLUED INTO POSITION WITH EC-847 ADHESIVE.

5 RUBBER PAD, MIL-R-6855, GLUED INTO POSITION WITH EC-847 ADHESIVE.

6 NAILING REFERENCE DIMENSIONS.

Figure 5 Outer Wing Shipping Container (Sheet 5)

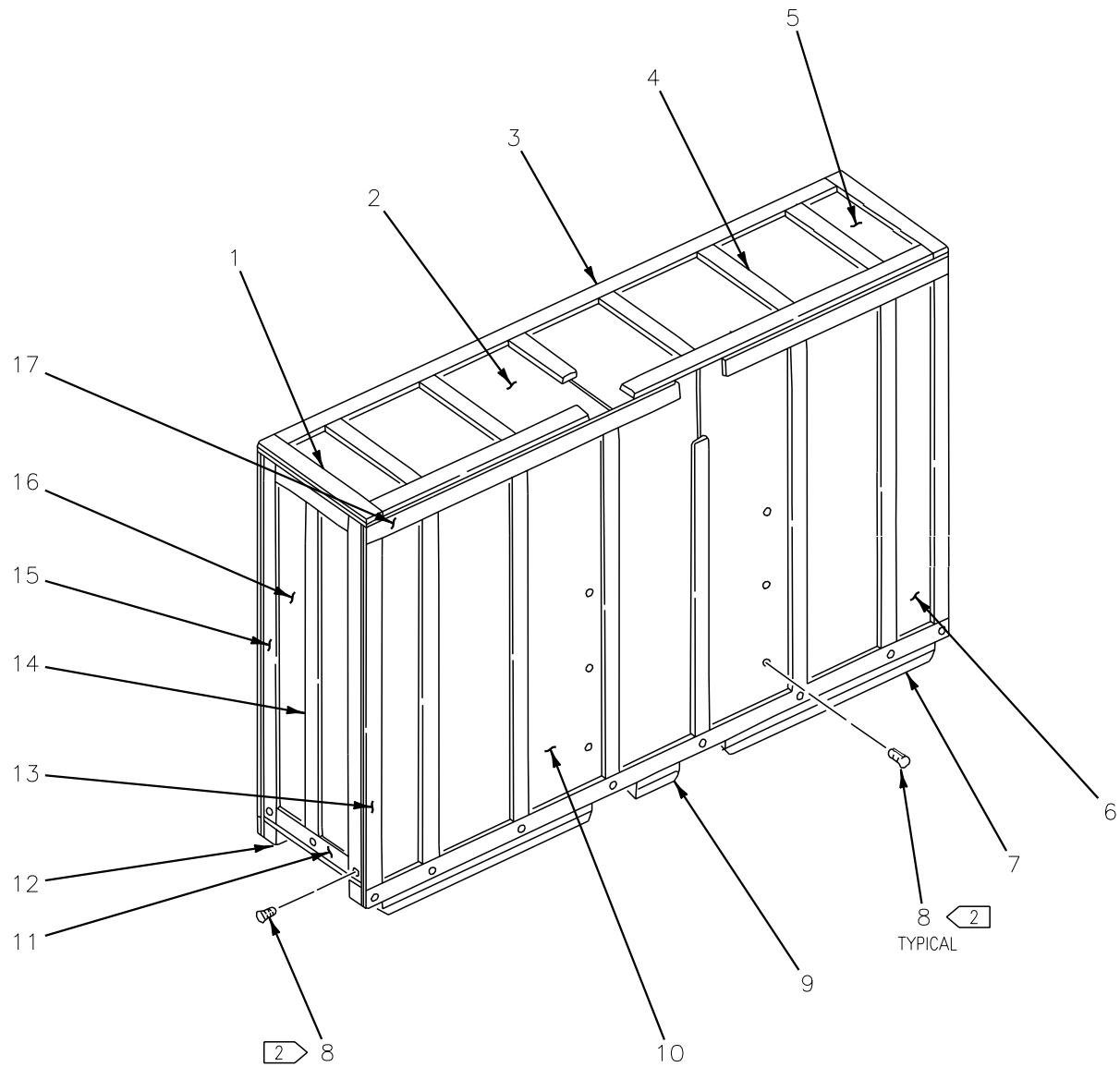


Figure 6. Inner Wing Shipping Container (Sheet 1)

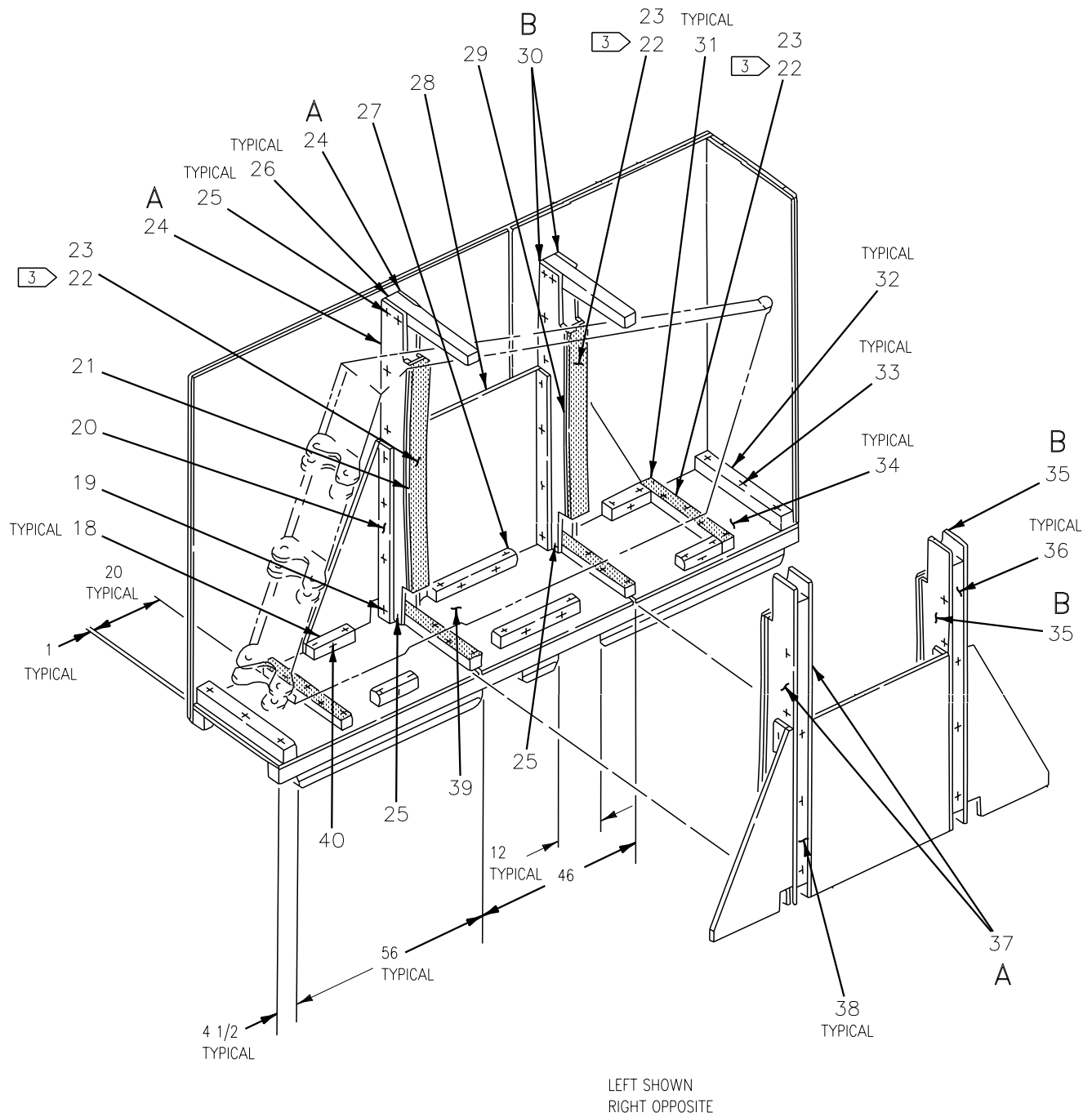
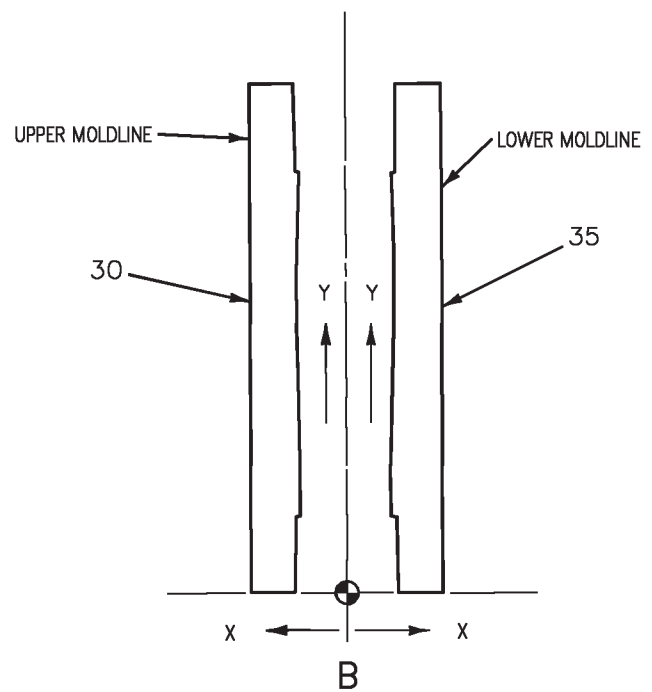
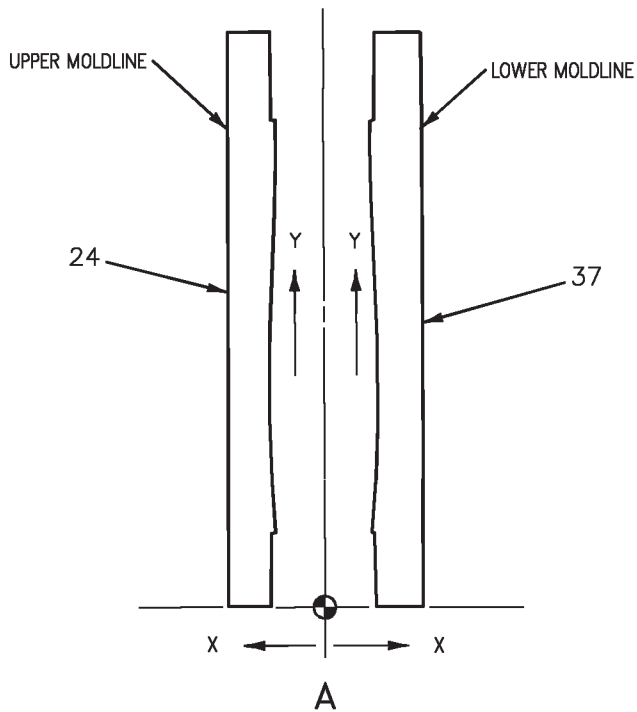


Figure 6. Inner Wing Shipping Container (Sheet 2)



18AC-SRM-20-(98-3)31-SCAN

INBOARD SURFACE CONTOUR		
	UPPER	LOWER
Y	X	X
O	8	8
11 1/2	8	8
11 1/2	3 9/16	4 9/16
15 1/2	3 3/4	4 3/4
19 1/2	3 7/8	4 13/16
23 1/2	4	4 29/32
27 1/2	4 3/32	5
31 1/2	4 3/16	5 1/16
35 1/2	4 7/32	5 3/32
39 1/2	4 1/4	5 1/8
43 1/2	4 1/4	5 1/8
47 1/2	4 7/32	5 1/8
51 1/2	4 5/32	5 1/8
55 1/2	4 1/8	5 1/16
59 1/2	4 1/16	5
63 1/2	4	4 7/8
67 1/2	3 7/8	4 3/4
71 1/2	3 3/4	4 5/8
73 1/2	3 11/16	4 1/2
73 1/2	8	8
87	8	8

OUTBOARD SURFACE CONTOUR		
	UPPER	LOWER
Y	X	X
O	8	8
11 1/2	8	8
11 1/2	3 3/16	3 3/16
15 1/2	3 3/8	3 9/32
19 1/2	3 1/2	3 3/8
23 1/2	3 9/16	3 3/16
27 1/2	3 5/8	3 17/32
31 1/2	3 11/16	3 19/32
35 1/2	3 11/16	3 5/8
39 1/2	3 11/16	3 11/32
43 1/2	3 21/32	3 5/8
47 1/2	3 21/32	3 5/8
51 1/2	3 19/32	3 5/8
55 1/2	3 1/2	3 17/32
59 1/2	3 13/32	3 7/16
63 1/2	3 5/16	3 5/16
63 1/2	8	8
77	8	8

Figure 6. Inner Wing Shipping Container (Sheet 3)

BILL OF MATERIALS				
INDEX	QTY	NOMENCLATURE	SIZE	REMARKS
1	2	CLEAT	1 X 4 X 33	
2	1	TOP, SHEATHING	1/4 X 35 X 71	
3	2	CLEAT	1 X 4 X 167	
4	6	CLEAT	1 X 4 X 28	
5	1	TOP, SHEATHING	1/4 X 35 X 96	
6	2	SIDE, SHEATHING	1/4 X 48 X 71	
7	8	RUB STRIP	2 X 4 X 54	
8	34	LAG SCREW	1/2 X 2 1/2	2
9	4	RUB STRIP	2 X 4 X 26	
10	2	SIDE, SHEATHING	1/4 X 48 X 96	
11	4	CLEAT	1 X 4 X 28	
12	2	SKID	4 X 4 X 167	
13	16	CLEAT	1 X 4 X 89	
14	2	CLEAT	1 X 4 X 84 1/2	
15	4	CLEAT	1 X 4 X 96	
16	2	END SHEATHING	1/4 X 33 X 92 1/2	
17	4	CLEAT	1 X 4 X 24	
18	4	BRACE	4 X 4 X 12	
19	16	CARRIAGE BOLT WITH HARDWARE	3/8 X 8 1/2	
20	4	CLEAT	2 X 4 X 48	
21	2	BACKUP, SHEATHING	1/4 X 4 1/2 X A/R	
22	2	CUSHION MATERIAL	1 X 4 1/2 X A/R	3
23	A/R	EC-847 ADHESIVE	AS REQUIRED	3
24	2	CONTOUR BOARD, SHEATHING	1/2 X 30 X 87	
25	18	CARRIAGE BOLT AND HARDWARE	3/8 X 5 1/2	
26	2	TIE SUPPORT	4 X 4 X 33	
27	2	BRACE	4 X 4 X 24	
28	2	GUSSET	3/4 X 24 X 48	
29	2	BACKUP, SHEATHING	1/4 X 4 1/2 X A/R	
30	2	CONTOUR BOARD, SHEATHING	1/2 X 30 X 77	
31	4	SUPPORT	4 X 4 X 31	
32	2	HEADER	4 X 4 X 33	
33	38	CARRIAGE BOLT WITH HARDWARE	3/8 X 5	
34	2	FLOOR, SHEATHING	1 X 33 X 56	
35	2	CONTOUR BOARD, SHEATHING	1/2 X 30 X 77	
36	2	FILLER	4 X 4 X 68	
37	2	CONTOUR BOARD, SHEATHING	1/2 X 30 X 87	
38	2	FILLER	4 X 4 X 78	
39	1	FLOOR, SHEATHING	1 X 33 X 46	
40	10	CARRIAGE BOLT WITH HARDWARE	1/2 X 5	

LEGEND

1. INNER WING WEIGHT IS 1096 POUNDS AND GROSS WEIGHT OF SHIPPING CONTAINER AND INNER WING IS APPROXIMATELY 1650 POUNDS.

2 USE 3/8-INCH TWIST DRILL TO MAKE PILOT HOLES.

3 CUSHION MATERIAL, POLYETHYLENE, PPP-C-1752, GLUED INTO POSITION WITH EC-847 ADHESIVE.

Figure 6. Inner Wing Shipping Container (Sheet 4)

INTERMEDIATE MAINTENANCE**STRUCTURE REPAIR****SHIPPING CONTAINERS****FORWARD FUSELAGE****Reference Material**

Aircraft Weapons Systems Cleaning and Corrosion Control.....	NAVAIR 01-1A-509
Packaging of Material Preservation (Volume 1)	NAVSUP PUB 502

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F/A-18B/D - Canopy Shipping Container.....	4
Nose Landing Gear (NLG) Forward Door Shipping Container.....	6
Nose Radome Shipping Container	2
Windshield Shipping Container.....	3

Record of Applicable Technical Directives

None

1. DESCRIPTION.

2. Shipping containers in this work package are for returning components to a higher level of maintenance or to cognizant supply activity for disposition. They are not meant for long-term storage or adverse shipping conditions. They are to be fabricated using common materials, readily available.

3. **GENERAL INFORMATION.** See figures 1 through 7.

a. Shipping containers provide protection for components against physical or environmental damage.

b. Shipping containers are constructed of wood or plywood with wood cleats, rub strips, and skids.

c. Interior contour boards are made from wood or plywood with cushioning to protect component. Contour boards secure component inside shipping container and protect component from damage caused by movement.

d. Damaged components may require additional boards to prevent further damage.

e. Loose hardware should be bagged and secured in shipping container.

4. PRESERVATION OF COMPONENTS.

Support Equipment Required

None

Materials Required

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
MIL-L-3150	Lubricating Oil, Preservative Oil
MIL-D-3464 TYPE 1	Desiccant
MIL-B-121 TY1GRACL1	Barrier Material
MIL-T-22085	Adhesive Tape, Preservation and Sealing Tape
A-A-883, TYPE 1	Pressure Sensitive Tape, Masking Tape
MS90376 MIL-T-22085	Caps or Plugs Adhesive Tape, Preservation and Sealing Tape
NAS817 NAS818	Cap Plug

a. Clean foreign material from component before preserving (NAVAIR 01-1A-509 and NAVSUP PUB 502).

b. Painted surfaces require no special coating.

c. Unpainted surfaces, nicks, scratches, or gouges in painted surfaces shall be coated with lubricating oil.

d. All hinges shall be coated with lubricating oil.

e. Put bags of desiccant into cavities and cover cavities with barrier material, taped in place with adhesive tape.

f. Cap or plug ends of electrical connectors with MS90376 caps or plugs, or use adhesive tape.

g. Cap or plug ends of pyrotechnic disconnects with NAS 817 caps or NAS 818 plugs.

5. PROCEDURES.

6. NOSE RADOME SHIPPING CONTAINER. See figure 1.

Support Equipment Required

None

Materials Required

See Figure 1.

7. Fabrication of Shipping Container and Installation of Radome. The nose radome shipping container is fabricated and the radome is installed as shown in figure 1, and procedures below:

- Assemble floor section of shipping container.
 - Nail skids (13) to floor (12).
 - Nail contour boards (15 through 18) details A through D to floor (12).
 - Position cushion material on contour boards (15 through 18).
- Position radome on assembled floor section (12), see figure 1.
- Attach sides (4) and ends (8) to floor (12) using lag screws (7).
- Nail mating edges of sides (4) and ends (8).
- Install contour board (19), detail E, with cushion material in position. Contour board is held in position by supports (11) and lag screws (7).
- Nail top (1) in position.

8. Radome Removal From Shipping Container.

- a. Remove top (1) from shipping container.
- b. Remove lag screws (7) holding supports (11).
- c. Remove contour board (19).
- d. Remove lag screws (7) from bottom periphery of shipping container.
- e. Carefully remove sides (4) and ends (8) by lifting over radome. Radome is free to remove from shipping container.

9. WINDSHIELD SHIPPING CONTAINER. See figure 2.**Support Equipment Required**

None

Materials Required

See Figure 2.

10. Fabrication of Shipping Container and Installation of Windshield. The windshield shipping container is fabricated and windshield is installed as shown in figure 2, and procedures below:

- a. Assemble shipping container, less top.
- b. Position cushion material.



Windshield transparency surfaces must be masked to prevent damage.

- c. Mask both transparency surfaces.
- d. Position windshield in shipping container.
- e. Install contour boards (17) and (18) using lag screws (6).
- f. Assemble and install top (2).

11. Windshield Removal From Shipping Container.

- a. Remove top (2) from shipping container.
- b. Remove lag screws (6) and remove contour boards (17) and (18). Windshield is free to remove from shipping container.

12. F/A-18A/C - CANOPY SHIPPING CONTAINER. See figure 3.**Support Equipment Required**

None

Materials Required

See Figure 3.

13. Fabrication of Shipping Container and Installation of Canopy. The canopy shipping container is fabricated and canopy is installed as shown in figure 3, and procedures below:

- a. Assemble floor section of shipping container.
 - (1) Nail skids (11) to floor (13) and (29).
 - (2) Nail spacers (31) and (32) to skids (11).
 - (3) Nail rub strips (7) and (10) to spacers (31) and (32).
 - (4) Attach headers (24) to floor (13) and (29) using bolts and hardware (30).
 - (5) Attach blocks (28) and supports (25), details B and D, to floor using bolts and hardware (41).

WARNING

EC847 is highly flammable. Do not use near open flame or sparks. Use only in well ventilated areas.

- (6) Glue cushion material (26) in position.
- b. Attach eyebolts (33) and (40) to floor (29).

- c. Assemble cable assemblies, using (34, 35, and 36).
- d. Attach cable assemblies to eyebolts (33 and 40).
- e. Mask both canopy transparency surfaces.



Do not rest canopy on fairings, structural damage shall result.

- f. Position canopy on floor section of shipping container and cut away cushion, as required, so canopy does not rest on fairing.
- g. Position spreader bar (37) on forward end of canopy.

(1) Attach lanyard (38) to eyebolt (40) 32 1/2 inches from end of container.

(2) Attach bungee cord (39) to canopy to keep spreader bar (37) in position.

h. Attach cable assemblies to forward latch, J-hook, on canopy.

(1) Tighten cable assemblies snug.

(2) Tighten cable assemblies maximum of 4 full turns to hold canopy in position.

(3) Safety turnbuckle.

i. Attach cable assemblies to canopy hinges.

(1) Tighten cable assemblies snug.

(2) Tighten cable assemblies maximum of 4 full turns to hold canopy in position.

(3) Safety turnbuckle.

j. Assemble sides, (8) ends, (15) and top (2) of shipping container.

(1) Sides (8) are attached to skids, (11) using lag screws (6).

(2) Ends (15) are attached to headers, (24) using lag screws (6).

(3) Mating surfaces of sides (8) and ends (15) are nailed in position.

(4) Nail top (2) in position.

14. Canopy Removal From Shipping Container.

a. Remove lag screws (6) from bottom periphery of shipping container.

b. Carefully lift shipping container sides, ends, and top, as one unit, from floor section.

c. Remove safety from turnbuckles, (35) 4 places.

d. Loosen turnbuckles (35) on cable assemblies at forward latch, J-hook.

e. Loosen turnbuckles (35) on hinge cable assemblies.

f. Remove cable assemblies from hinge.

g. Remove spreader bar bungee cord (39) from canopy.

h. Remove spreader (37) bar from forward end of canopy. Canopy is free to remove from shipping container.

15. F/A-18B/D - CANOPY SHIPPING CONTAINER.

See figure 4.

Support Equipment Required

None

Materials Required

See Figure 4.

16. Fabrication of Shipping Container and Installation of Canopy. The canopy shipping container is fabricated and canopy is installed as shown in figure 4, and procedures below:

a. Assemble floor section of shipping container.

(1) Nail skids (19) to floor (26).

(2) Nail rub strips (27) and (18) to skids (19).

(3) Attach headers (24) to floor (26) using bolts and hardware (23).

(4) Nail braces (33) to floor (26).

(5) Attach blocks (21) to braces (33) using bolts and hardware (25).

(6) Nail support (32) to blocks (21).

(7) Nail support (39) to support (32).

WARNING

EC847 is highly flammable. Do not use near open flame or sparks. Use only in well ventilated areas.

(8) Glue cushion material (22), to supports (39) and (32) using adhesive (40) as shown in detail C and D.

(9) Nail blocks (13) to header (24).

WARNING

(10) Glue cushion material (14) using adhesive (40) to blocks (13).

(11) Attach support (29) to floor (26) using bolts and hardware (30), see detail A.

WARNING

(12) Glue cushion material, (31), detail E, using adhesive (40) to support (29).

b. Attach eyebolts (36) to floor (26), see details A and B.

c. Assemble cable assembly using (34), (38), and (37), see detail D.

d. Attach cable assembly to eyebolts (36) using clips (35).

e. Fabricate contour board (28).

WARNING

EC847 is highly flammable. Do not use near open flame or sparks. Use only in well ventilated areas.

f. Glue cushion material, (31) to contour board (28), see detail A.

g. Mask both canopy transparency surfaces.

CAUTION

Do not rest canopy on fairings, structural damage shall result.

h. Position canopy on floor section of shipping container, making sure weight of canopy does not rest on fairings. Make sure forward end of canopy is resting on cushion material (31).

i. Secure aft end of canopy to floor section as below:

(1) Attach cable to canopy hinge bracket holes and take up slack.

(2) Tighten turnbuckle (38) maximum of 4 full turns.

(3) Safety turnbuckle.

CAUTION

Make sure contour board is well cushioned to prevent structural damage to canopy.

j. Install cushioned contour board (28) using bolts and hardware (30).

k. Assemble sides, (6) ends, (11) and top (4) of shipping container.

(1) Sides (6) are attached to skids (19) using lag screws (8).

(2) Ends are attached to headers (24) using lag screws (8).

(3) Mating surfaces of sides (6) and ends (11) are nailed in position.

(4) Nail top (4) in position.

17. Canopy Removal From Shipping Container.

- a. Remove lag screws (8) from bottom periphery of shipping container.
- b. Carefully lift shipping container sides, ends, and top, as one unit, from floor section.
- c. Remove safety from turnbuckle (38).
- d. Loosen and disconnect cable at turnbuckle (38).
- e. Remove contour board (28) by removing bolts and hardware (30). Canopy is free to remove from shipping container.

18. **DOOR 18 SHIPPING CONTAINER.** See figure 5.

Support Equipment Required

None

Materials Required

See Figure 5.

19. **Fabrication of Shipping Container and Installation of Door 18.** Fabricate shipping container and install door 18 as shown in figure 5.

20. **NOSE LANDING GEAR (NLG) FORWARD DOOR SHIPPING CONTAINER.** See figure 6.

Support Equipment Required

None

Materials Required

See Figure 6.

21. **Fabrication of Shipping Container and Installation of NLG Forward Door.** Fabricate shipping container and install NLG forward door as shown in figure 6.

22. **FORWARD FUSELAGE SHIPPING CONTAINER.** See figure 7.

Support Equipment Required

Part Number or Type Designation	Nomenclature
—	Forward Fuselage Aircraft Maintenance Hoist

Materials Required

See figure 7.

23. **Fabrication of Shipping Container and Installation of Forward Fuselage.** Fabricate shipping container and install forward fuselage as shown in figure 7 and steps below:

a. Assemble floor section per figure 7 and substeps below:

(1) Attach headers (16) to skids (17) using carriage bolts (15).

(2) Nail rub strips (10) and (11) to skids (17).

(3) Attach load carrying brace (13) to skids (17) using carriage bolts (15).

(4) Nail floor boards (7) to skids (17).

(5) Nail blocking (44) to floor boards (7).

(6) Attach load carrying braces (9) to skids (17) using carriage bolts (15).

(7) Nail fillers (8, 12, and 14) to skids (17).

(8) Make contour board (32) and contour fillers (30), see detail M.

(9) Nail contour board (32) to contour fillers (30), see detail M.

WARNING

EC847 is highly flammable. Do not use near open flame or sparks. Use only in well ventilated areas.

(10) Glue cushion material (29) to contour boards (32) and contour fillers (30) using adhesive (73), see detail D.

(11) Attach blocking (33) to contour assembly (30 and 32) using carriage bolts (34).

(12) Make gussetts (36).

(13) Attach blocking (35) to gusset (36) using carriage bolts (34).

(14) Attach gussetts (36) to blocking (33) using lag screws (72).

(15) Attach assembled aft contour assembly, see detail E, to floor section using carriage bolts (31).

(16) Make contour board (38) and contour fillers (37).

(17) Nail contour boards (38) to contour fillers (37).

WARNING

EC847 is highly flammable. Do not use near open flame or sparks. Use only in well ventilated areas.

(18) Glue cushion material (3) to contour boards (38) and contour fillers (37) using adhesive (73).

(19) Attach blocking (33) to contour assembly (30 and 32) using carriage bolts (34).

(20) Attach blocking (35) to gussetts (36) using carriage bolts (34).

(21) Center nylon webbing (6) in forward contour assembly, see detail D, before bolting in position.

(22) Attach assembled forward contour assembly, see detail D, to floor section using carriage bolts (31).

b. Make tie down, steel channel, see detail F.

c. Make tooling fixture, see detail H.

d. Attach tie down, steel channel (40) to load carrying brace (13) using carriage bolts (41).

e. Using forward fuselage aircraft maintenance hoist, P/N TBD, slowly lift forward fuselage.

f. Attach tooling fixture, see detail H, inside fuselage to nose landing gear attach point at Z87.050 and Y278.700.

g. Slowly position forward fuselage on contour board assemblies.

h. Slowly position forward fuselage tooling fixture detail H, on tie down, steel channel, (40) until attach holes are aligned.

i. Loosely bolt tooling fixture to tie down, steel channel (40) using carriage bolts (41).

j. With forward fuselage resting on contour board assemblies, details D and E, inspect for correct positioning of fuselage before tightening carriage bolts (41) connecting tooling fixture, detail H, to tie down, steel channel (40).

k. Tighten carriage bolts (41) attaching tooling fixture, detail H, to tie down, steel channel (40).

l. Fill forward fuselage voids with desiccant (4).

m. Attach barrier material (2) to nose section of forward fuselage.

n. Position nylon webbing (6) through ratchet buckle (5).

o. Position cushion material (3) under nylon webbing (6).

p. Draw nylon webbing (6) tight through ratchet buckle (5).

q. Wrap remainder of forward fuselage in barrier material (2).

r. Make brace assembly, detail G.

s. Install brace assembly, detail G, between forward and aft contour board assemblies on floor section using carriage bolts (39).

t. If shipping container is to be enclosed:

(1) Make sides, see detail J.

(2) Make ends, see detail K.

(3) Make top, see detail L.

(4) Install ends, detail K, using lag screws (1).

(5) Install sides, see detail J, using lag screws (1).

(6) Nail top, detail L, in position.

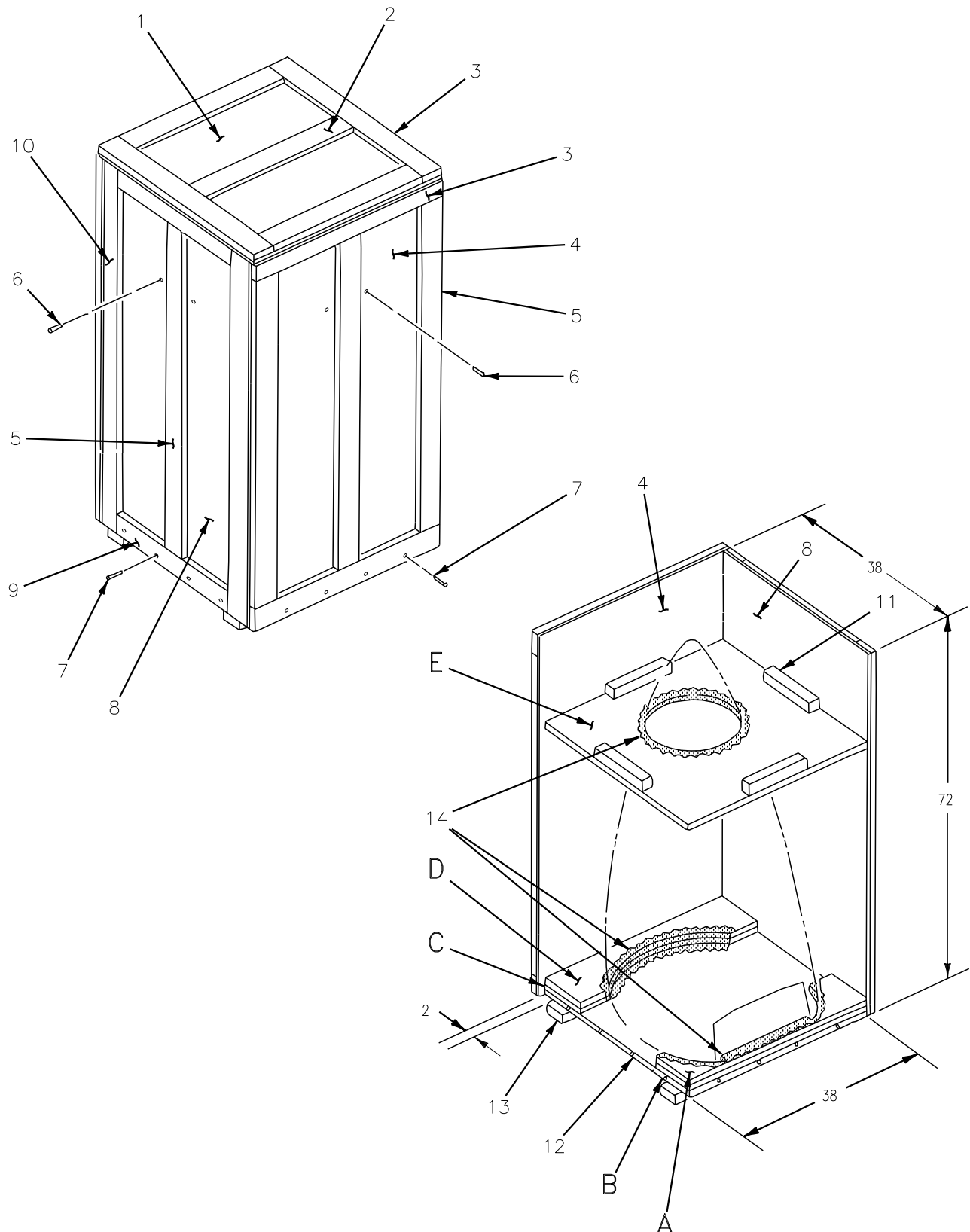


Figure 1. Nose Radome Shipping Container (Sheet 1)

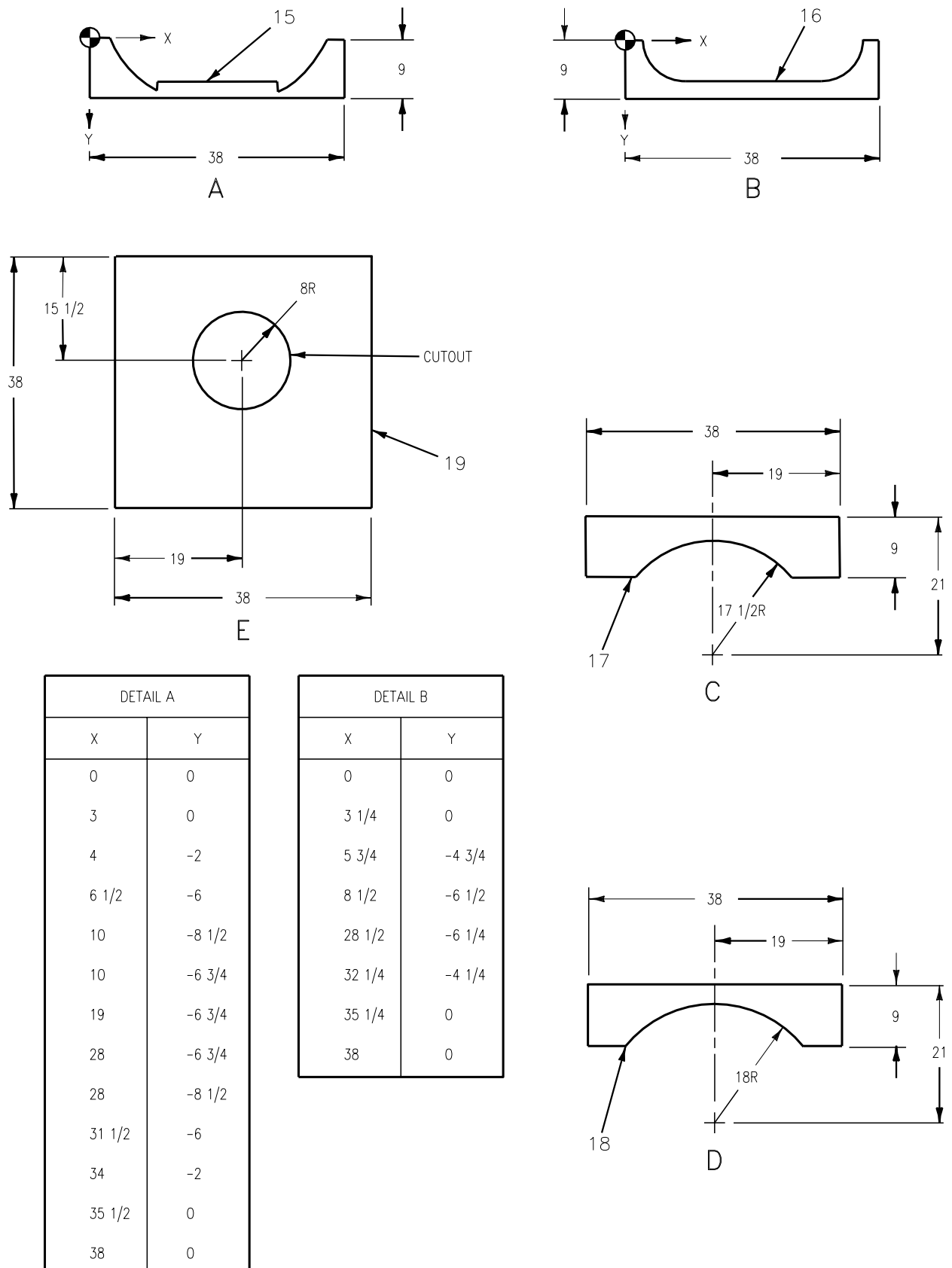


Figure 1. Nose Radome Shipping Container (Sheet 2)

BILL OF MATERIALS				
INDEX	QTY	NOMENCLATURE	SIZE	REMARKS
1	1	TOP, SHEATHING	1/2 X 40 X 40	
2	3	CLEAT	1 X 4 X 33	
3	6	CLEAT	1 X 4 X 40	
4	2	SIDE, SHEATHING	1/2 X 40 X 72	
5	8	CLEAT	1 X 4 X 65	
6	8	LAG SCREW	3/8 X 2	◀ 3
7	16	LAG SCREW	1/4 X 2 1/2	◀ 3
8	2	END, SHEATHING	1/2 X 38 X 72	
9	4	CLEAT	1 X 4 X 31	
10	4	CLEAT	1 X 4 X 72	
11	4	SUPPORT	2 X 2 X 12	
12	1	FLOOR, SHEATHING	1 X 38 X 38	
13	2	SKID	2 X 4 X 40	
14	A/R	CUSHION MATERIAL	AS REQUIRED	◀ 4
15	1	CONTOUR BOARD	1 X 9 X 38	
16	1	CONTOUR BOARD	1 X 9 X 38	
17	1	CONTOUR BOARD	1 X 9 X 38	
18	1	CONTOUR BOARD	1 X 9 X 38	
19	1	CONTOUR BOARD	1 X 38 X 38	

LEGEND

- RADOME WEIGHT IS 125 POUNDS AND GROSS WEIGHT OF SHIPPING CONTAINER AND RADOME IS APPROXIMATELY 295 POUNDS.
- WRAP RADOME IN L-P-378, TYPE 1, CLASS 1, GRADE B, FINISH 1, 0.006 THICK.

◀ 3 USE 3/16 INCH TWIST DRILL TO MAKE PILOT HOLES.

◀ 4 CUSHION MATERIAL, POLYETHYLENE, PPP-C-1752.

Figure 1. Nose Radome Shipping Container (Sheet 3)

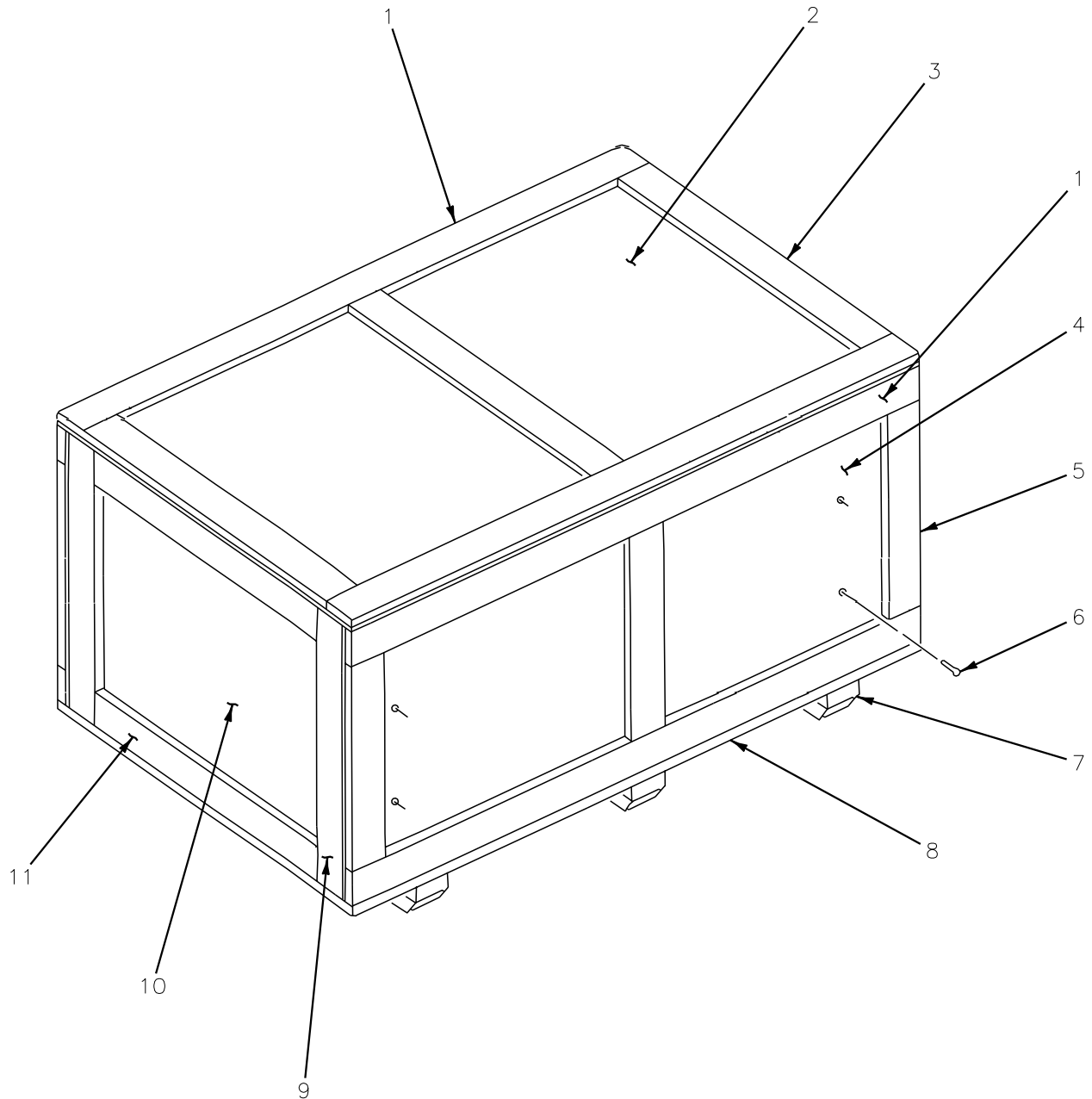


Figure 2. Windshield Shipping Container (Sheet 1)

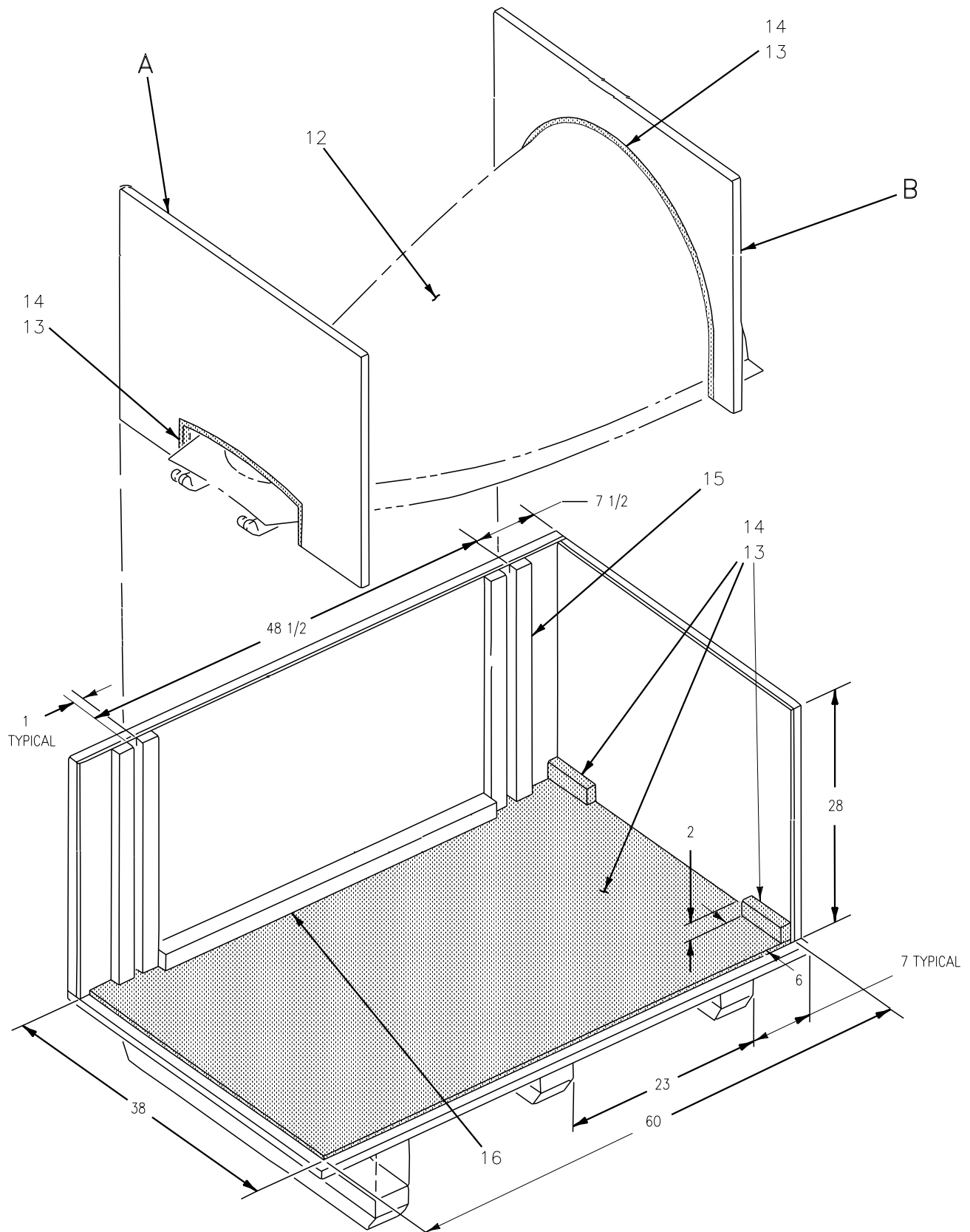


Figure 2. Windshield Shipping Container (Sheet 2)

Figure 2. Windshield Shipping Container (Sheet 3)

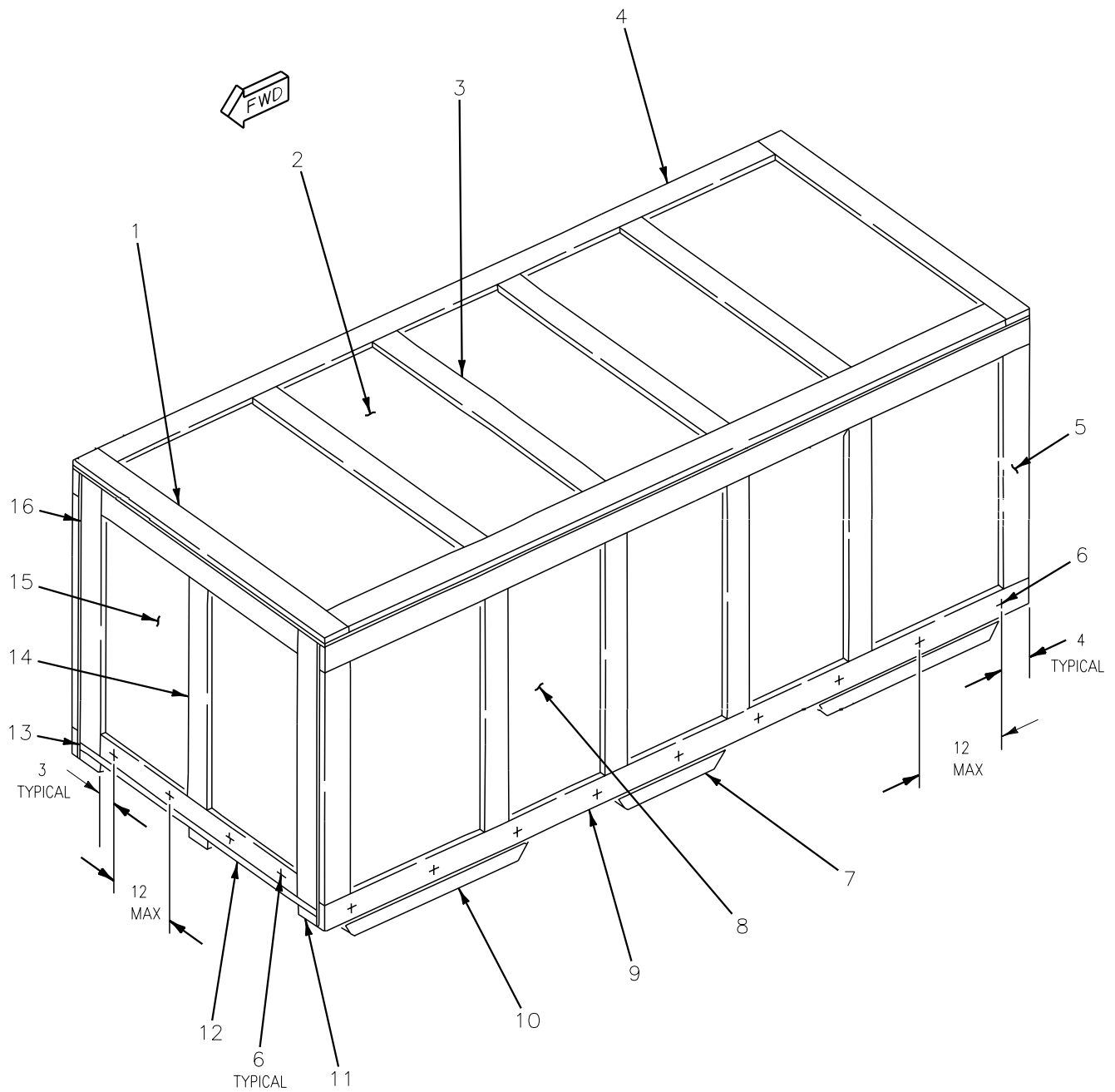


Figure 3. F/A-18A/C Canopy Shipping Container (Sheet 1)

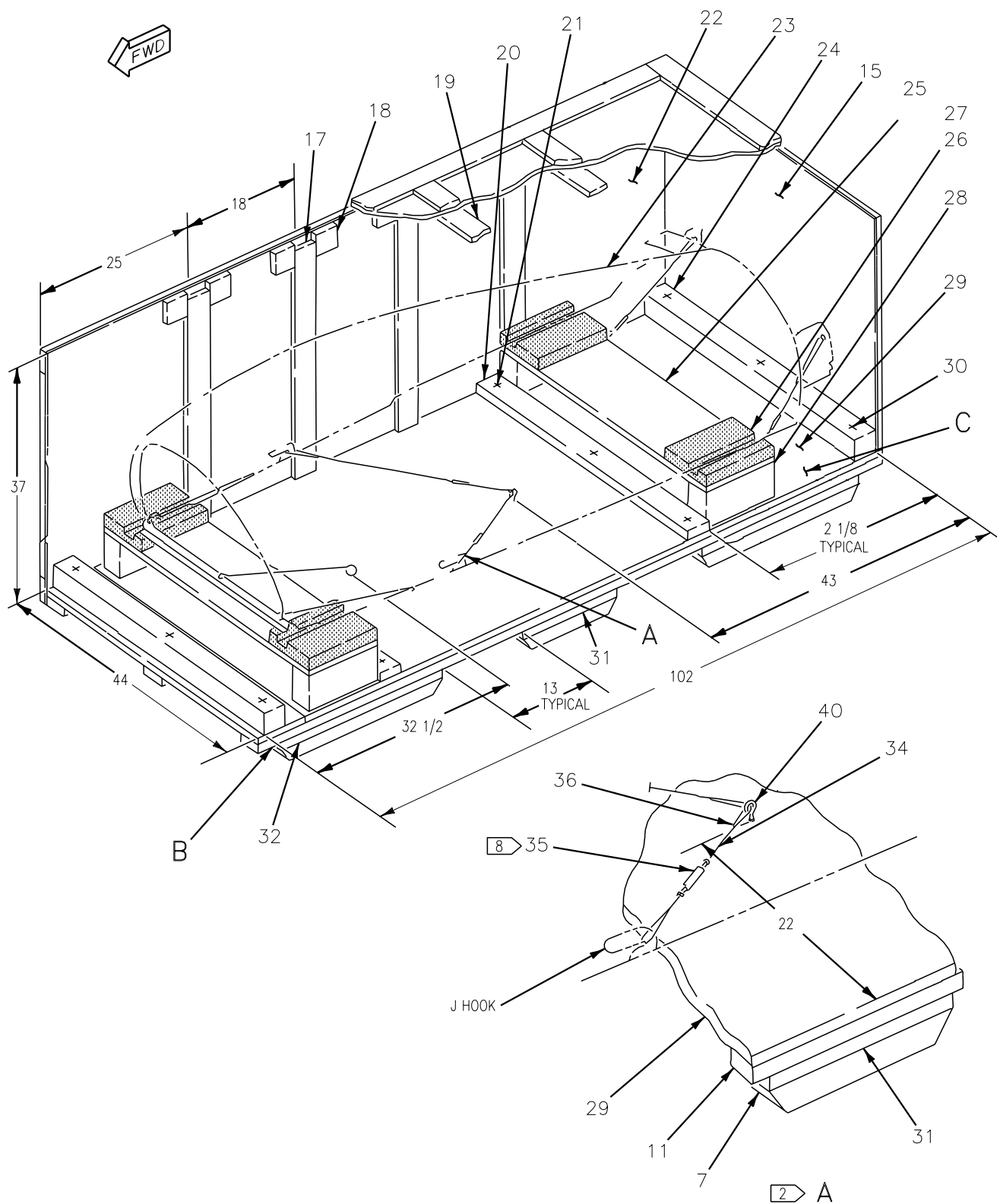


Figure 3. F/A-18A/C Canopy Shipping Container (Sheet 2)

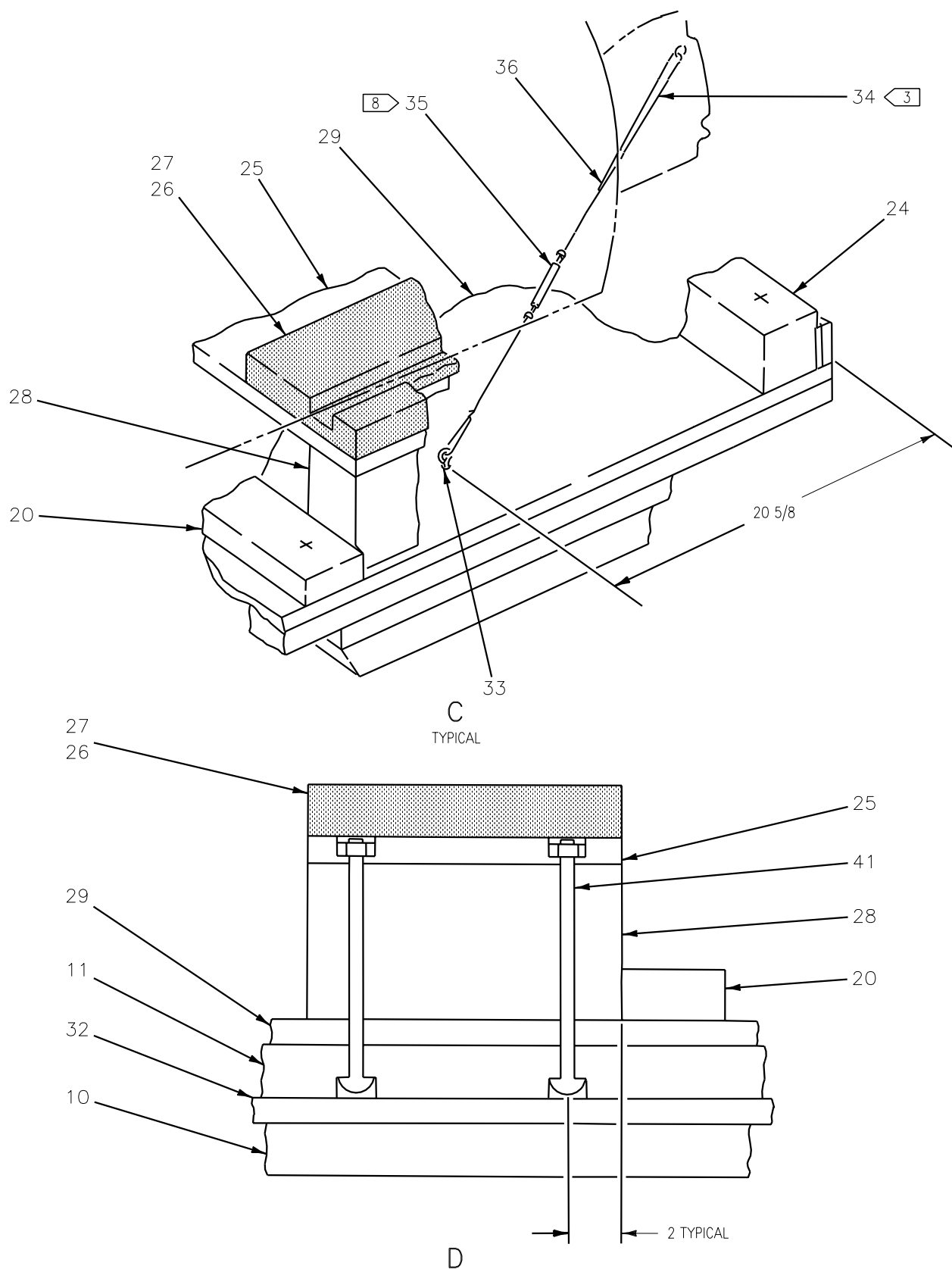


Figure 3. F/A-18A/C Canopy Shipping Container (Sheet 4)

BILL OF MATERIALS				
INDEX	QTY	NOMENCLATURE	SIZE	REMARKS
1	2	CLEAT	1 X 4 X 46	
2	1	TOP, SHEATHING	1/4 X 46 X 104	
3	4	CLEAT	1 X 4 X 39	
4	2	CLEAT	1 X 4 X 97	
5	12	CLEAT	1 X 4 X 32 1/2	
6	26	LAG SCREW	3/8 X 3	11
7	2	RUB STRIP	2 X 4 X 16	
8	2	SIDE, SHEATHING	1/4 X 39 1/2 X 104	
9	2	CLEAT	1 X 4 X 104	
10	4	RUB STRIP	2 X 4 X 27	
11	3	SKID	2 X 4 X 104	
12	4	CLEAT	1 X 4 X 37	
13	1	FLOOR, SHEATHING	1 X 8 X 44	
14	2	CLEAT	1 X 4 X 30	
15	2	END, SHEATHING	1/4 X 37 X 44	
16	4	CLEAT	1 X 4 X 37	
17	8	JOIST SUPPORT	1 X 4 X 37	
18	16	JOIST SUPPORT	1 X 4 X 4	
19	8	JOIST	1 X 4 X 44	
20	2	CROSS MEMBER	2 X 4 X 44	
21	6	CARRIAGE BOLT AND HARDWARE	3/8 X 4 1/2	
22	2	SIDE, SHEATHING	1/4 X 39 1/2 X 104	
23	A/R	MASKING PAPER	AS REQUIRED	PROTEX 10V 10
24	2	HEADER	4 X 4 X 44	
25	2	SUPPORT	1 X 12 X 42 1/2	
26	A/R	CUSHION MATERIAL	AS REQUIRED	7 9
27	A/R	EC847 ADHESIVE	AS REQUIRED	9
28	4	BLOCK	4 X 6 X 12	
29	1	FLOOR, SHEATHING	1 X 44 X 96	
30	6	CARRIAGE BOLT AND HARDWARE	1/2 X 6 1/2	
31	2	SPACER	1 X 4 X 16	
32	4	SPACER	1 X 4 X 27	
33	2	EYE BOLT	3/8 X 1	
34	2	WIREROPE	1/8 X A/R	3
35	4	TURNBUCKLE	1/8	8
36	16	CLIPS	1/8	
37	1	SPREADER BAR	3/16 X 1 1/2 X 1 1/2 X 30 1/2	ALUM, 5 6
38	1	LANYARD, WIREROPE	1/8 X 70	MIL-W-5824, PLASTIC COATED 6
39	2	BUNGEE CORD	18	COMM.
40	2	EYE BOLT	3/8 X 1 1/2	11
41	8	CARRIAGE BOLT AND HARDWARE	3/8 X 8	

LEGEND

1. CANOPY WEIGHT IS 125 POUNDS AND GROSS WEIGHT OF SHIPPING CONTAINER AND CANOPY IS APPROXIMATELY 460 POUNDS.
2. ATTACH WIREROPE TO FORWARD LATCH, SEE DETAIL A.
3. ATTACH WIREROPE TO FORWARD LATCH, SEE DETAIL C.
4. SECURE SPREADER BAR TO FORWARD END OF CANOPY WITH BUNGEE CORDS.
5. PAINT SPREADER BAR RED, STENCIL; PART OF SHIPPING CONTAINER, DO NOT REMOVE.
6. ATTACH ONE END OF LANYARD (38) TO SPREADER BAR (37) AND OTHER END OF LANYARD (38) TO EYEBOLT (33) 32 1/2 INCHES FROM END OF CONTAINER.
7. CUT OUT CUSHION SO WEIGHT OF CANOPY DOES NOT REST ON FAIRING.
8. REMOVE SLACK FROM CABLES WITH TURNBUCKLES, TIGHTEN MAXIMUM OF 4 TURNS.
9. CUSHION MATERIAL, POLYETHYLENE, PPP-C-1752, GLUED INTO POSITION WITH EC847 ADHESIVE.
10. MASK INNER AND OUTER CANOPY TRANSPARENCY SURFACES WITH PROTEX 10V PAPER.
11. USE 1/4-INCH TGWIST DRILL TO MAKE PILOT HOLES.

Figure 3. F/A-18A/C Canopy Shipping Container (Sheet 5)

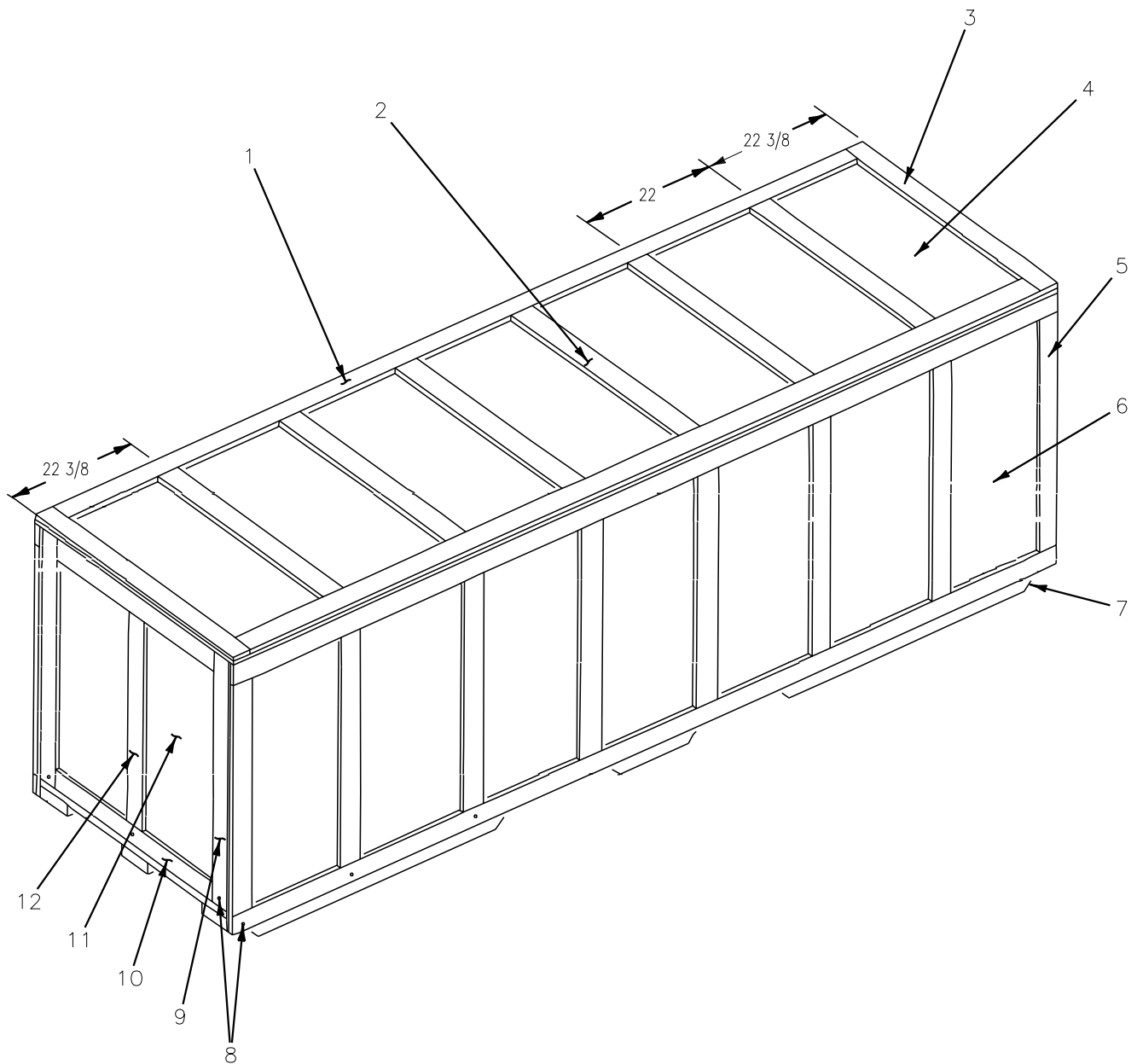


Figure 4. F/A-18B/D Canopy Shipping Container (Sheet 1)

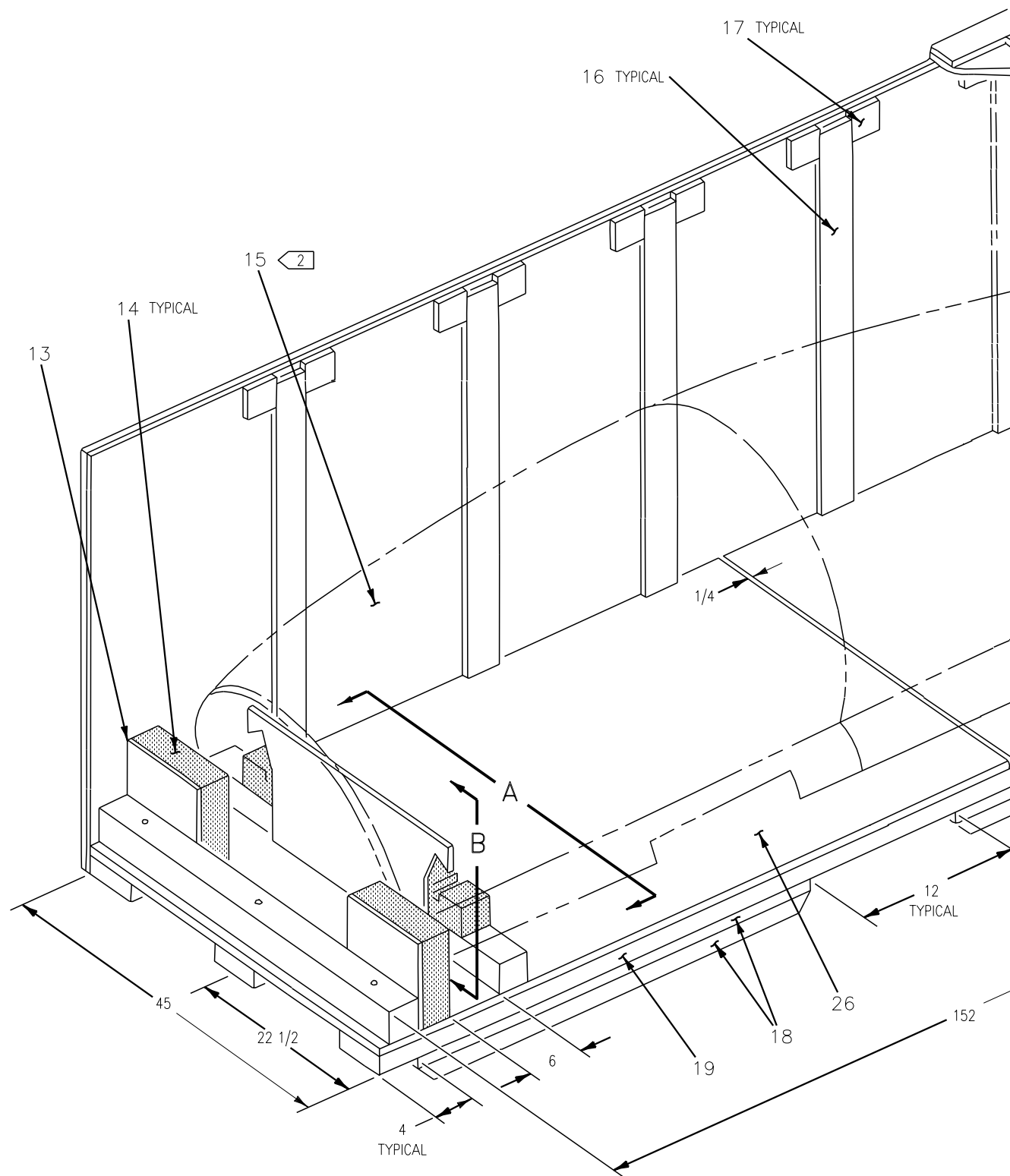


Figure 4. F/A-18B/D Canopy Shipping Container (Sheet 2)

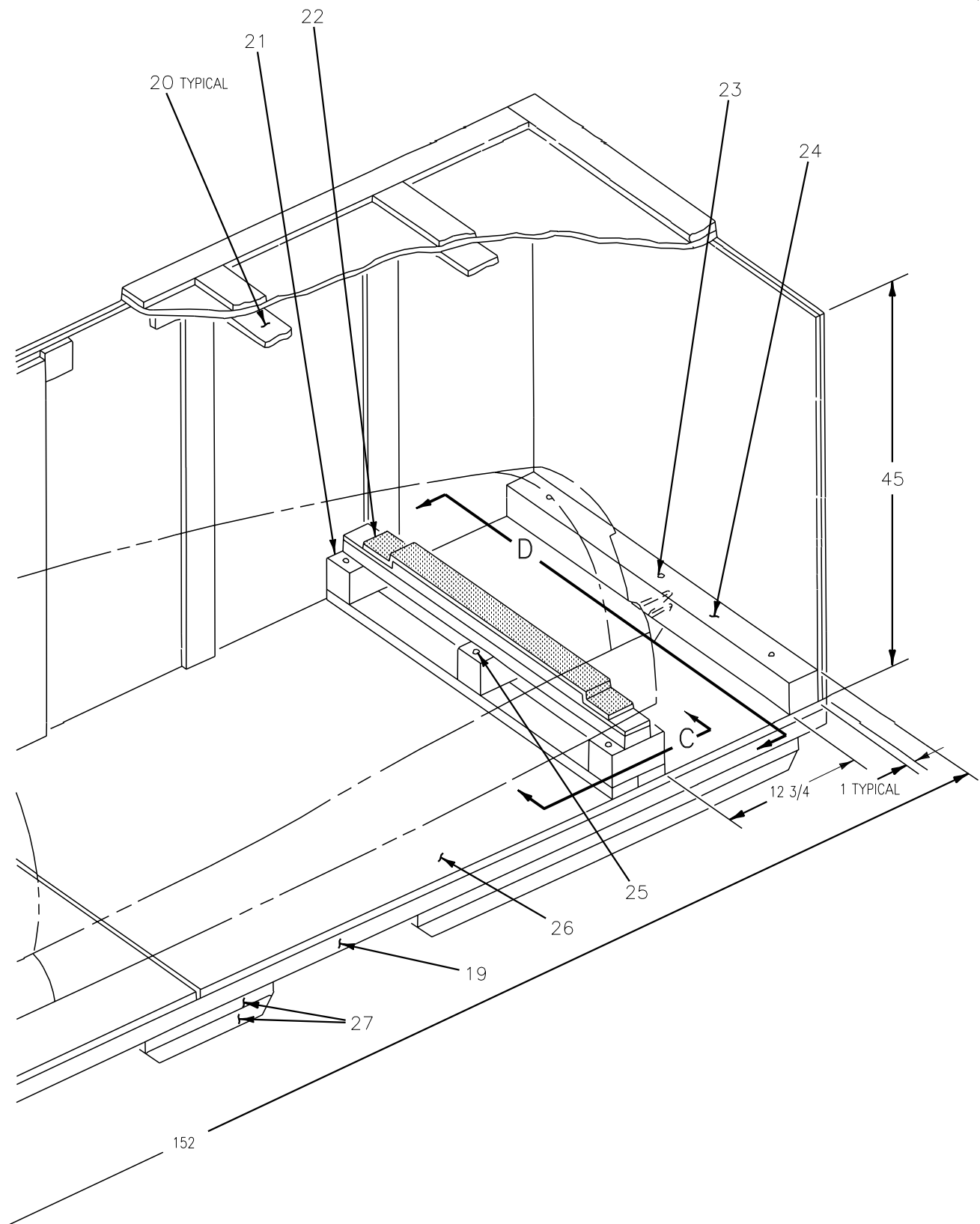


Figure 4. F/A-18B/D Canopy Shipping Container (Sheet 3)

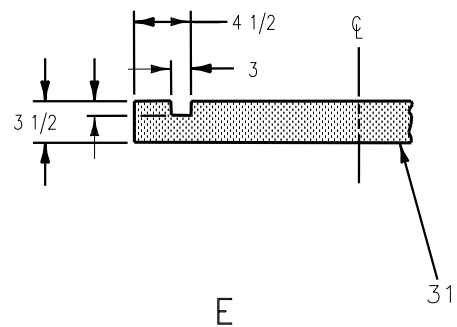
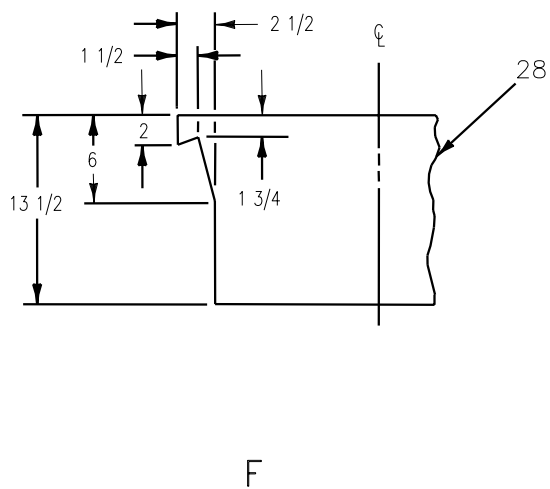
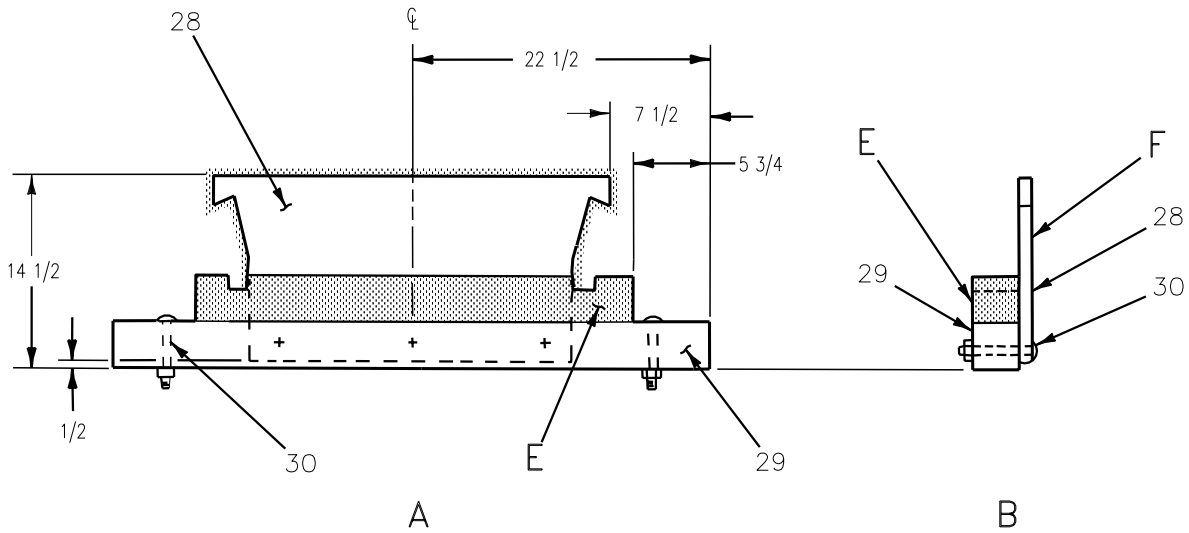


Figure 4. F/A-18B/D Canopy Shipping Container (Sheet 4)

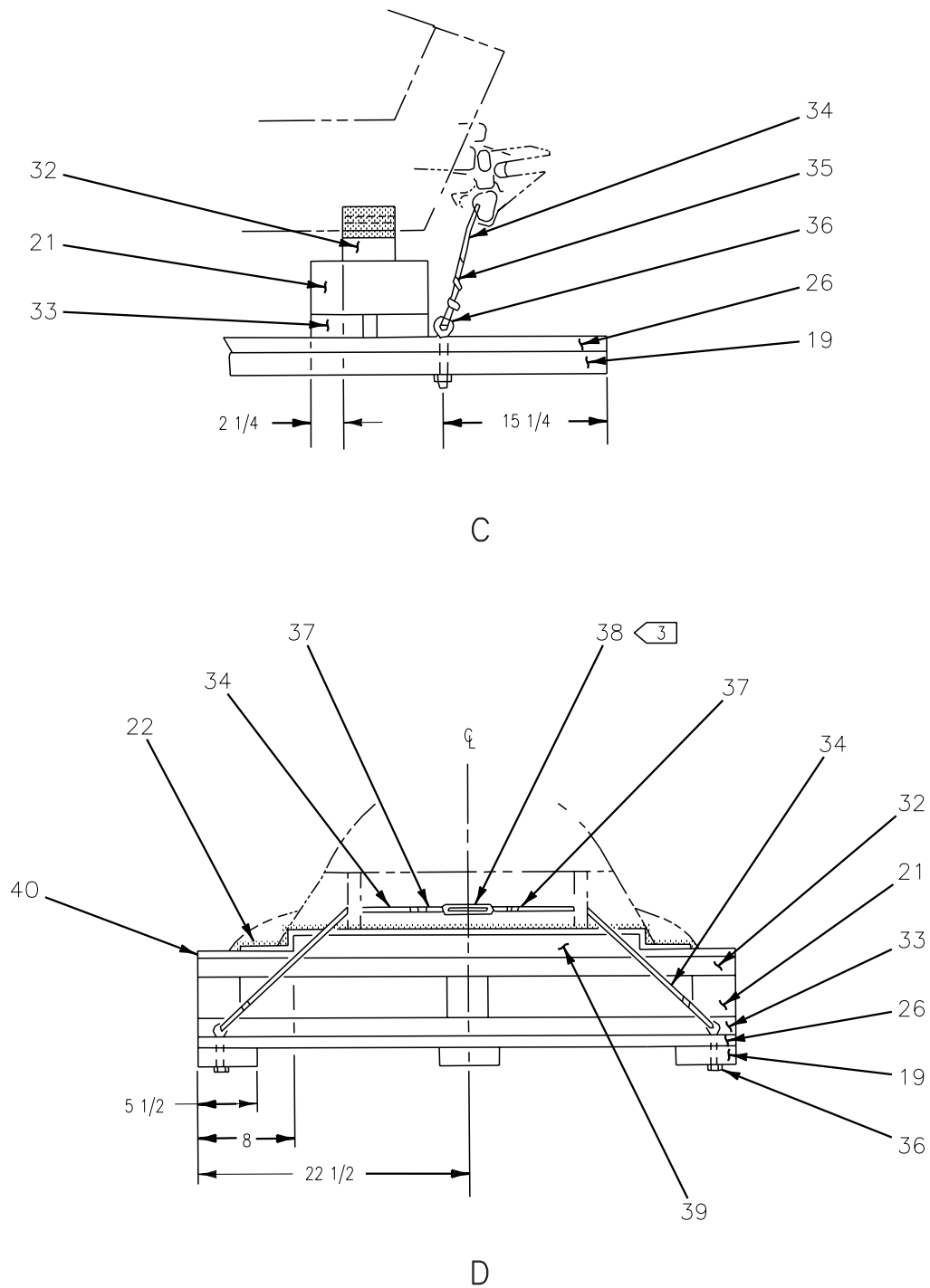


Figure 4. F/A-18B/D Canopy Shipping Container (Sheet 5)

BILL OF MATERIALS				
INDEX	QTY	NOMENCLATURE	SIZE	REMARKS
1	2	CLEAT	1 X 4 X 148	
2	6	CLEAT	1 X 4 X 41	
3	2	CLEAT	1 X 4 X 47	
4	1	TOP, SHEATHING	1/4 X 47 X 154	
5	16	CLEAT	1 X 4 X 40 1/2	
6	2	SIDE, SHEATHING	1/4 X 47 1/2 X 154	
7	4	CLEAT	1 X 4 X 154	
8	22	LAG SCREW	3/8 X 2	
9	4	CLEAT	1 X 4 X 45	
10	4	CLEAT	1 X 4 X 38	
11	2	END, SHEATHING	1/4 X 45 X 45	
12	2	CLEAT	1 X 4 X 38	
13	2	BLOCK, SHEATHING	1 X 10X 10 1/2	
14	2	CUSHION MATERIAL	3 1/2 X 10 10 1/2	◀ 4 ▶ 5
15	A/R	MAKING PAPER	AS REQUIRED	6 ▶
16	12	JOIST SUPPORT	1 X 4 X 44 1/2	
17	24	SUPPORT	1 X 1 X 4	
18	12	RUB STRIP	1 X 4 X 48	
19	3	SKID	2 X 6 X 154	
20	6	JOIST	1 X 4 X 45	
21	3	BLOCK	4 X 4 X 8	
22	A/R	CUSHION MATERIAL	AS REQUIRED	◀ 4 ▶ 5
23	6	CARRIAGE BOLT AND HARDWARE	1/2 X 6	
24	2	HEADER	4 X 4 X 45	
25	6	CARRIAGE BOLT AND HARDWARE	1/2 X 9	
26	2	FLOOR, SHEATHING	1 X 45 X 77	
27	6	RUB STRIP	2 X 4 X 16	
28	1	CONTOUR BOARD, SHEATHING	1 X 13 1/2 X 30	
29	1	SUPPORT	4 X 4 X 45	
30	6	CARRIAGE BOLT AND HARDWARE	1/2 X 5	
31	1	CUSHION MATERIAL	3 1/2 X 4 1/2 X 33 1/2	◀ 4 ▶ 5
32	1	SUPPORT	2 X 4 X 45	
33	2	BRACE	2 X 4 X 45	
34	2	WIRE ROPE	1/4 X (7 X 7) AR	
35	4	CLIPS	1/4	
36	2	EYEBOLT	1/2 X 4	
37	2	THREADED TERMINAL	1/4	
38	1	TURNBUCKLE	1/4 OPEN BODY	◀ 3 ▶
39	1	SUPPORT	2 X 4 X 29	
40	A/R	EC-847 ADHESIVE	AS REQUIRED	◀ 5 ▶

LEGEND

1. CANOPY WEIGHT IS 233 POUNDS AND GROSS WEIGHT OF SHIPPING CONTAINER AND CANOPY IS APPROXIMATELY 600 POUNDS.

2 ▶ WEIGHT OF CANOPY MUST NOT RESET ON FAIRINGS.

3 ▶ REMOVE ALL SLACK FROM CABLE WITH TURNBUCKLE. TIGHTEN TURNBUCKLE ON FULL TURN AND SAFETY.

4 ▶ GLUE CUSHION MATERIAL TO CONTOUR BOARD.

5 ▶ CUSHION MATERIAL, POLYETHYLENE, PPP-C-1752, GLUED INTO POSITION WITH EC-847 ADHESIVE.

6 ▶ MASK INNER AND OUTER CANOPY TRANSPARENCY SURFACES WITH PROTEX 10V PAPER.

Figure 4. F/A-1B8/D Canopy Shipping Container (Sheet 6)

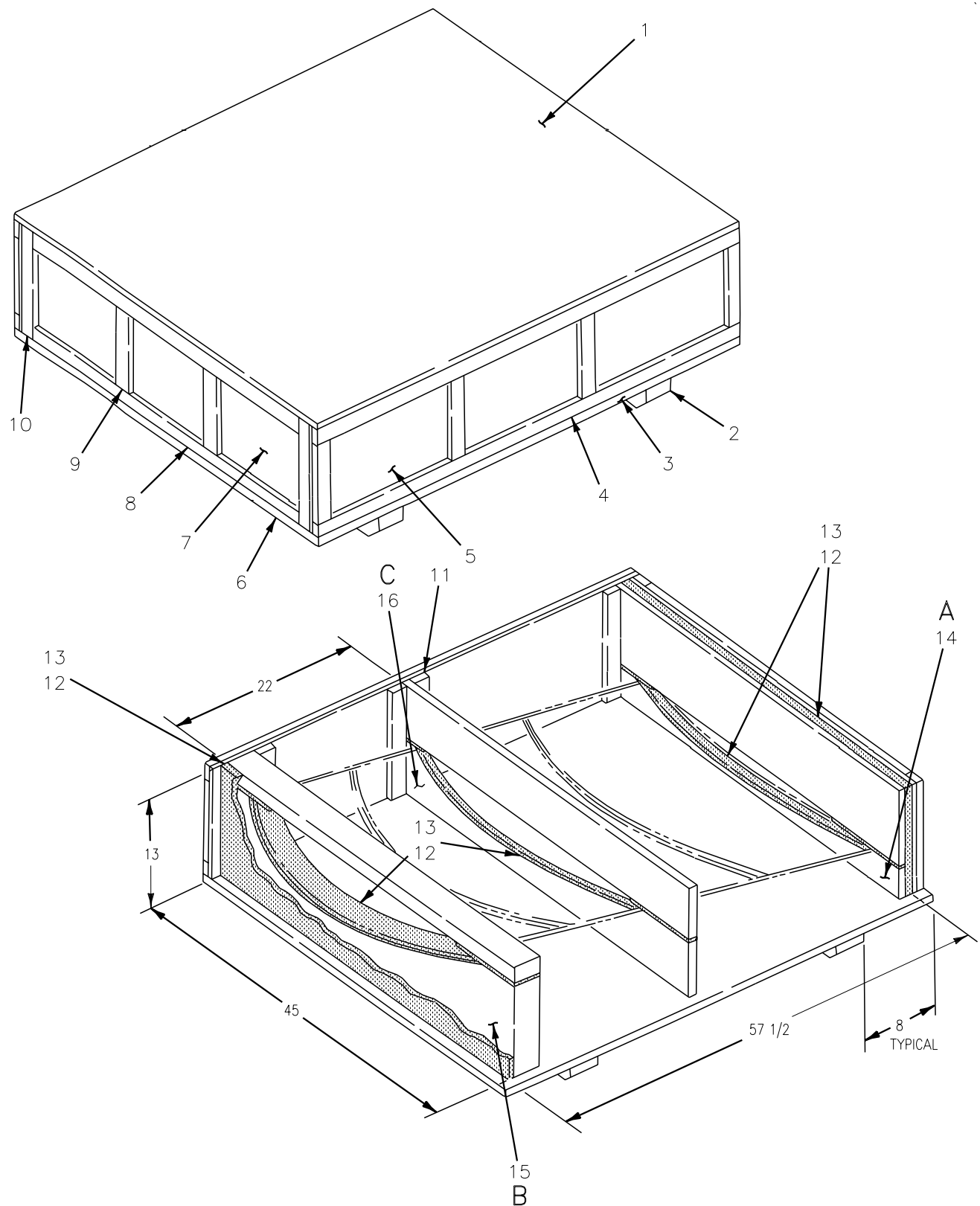
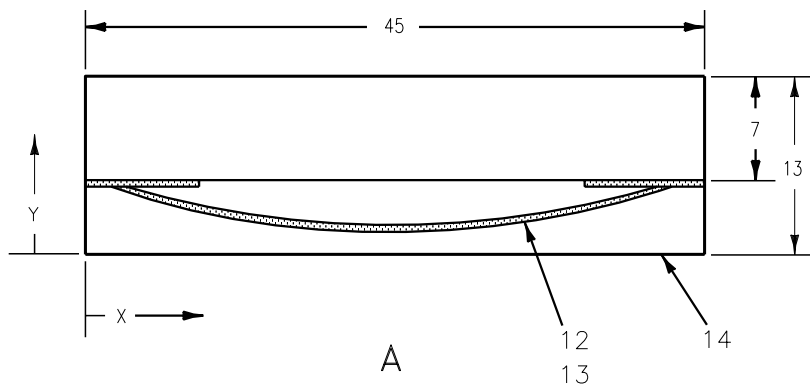
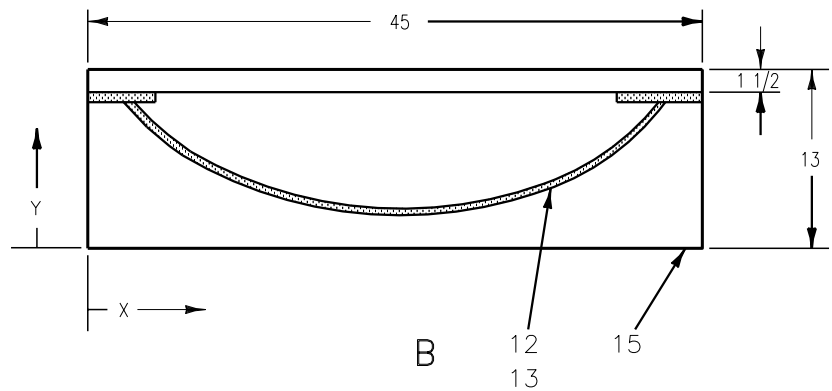


Figure 5. Door 18 Shipping Container (Sheet 1)



A	
X	Y
0	11 1/2
2 3/16	11 1/2
2 1/2	10
3	8 13/16
3 1/2	7 15/16
4	7 1/8
4 1/2	6 1/2
5	5 15/16
5 1/2	5 1/2
6 1/2	4 3/4
7 1/2	4 3/16
8 1/2	3 3/4
9 1/2	3 3/8
10 1/2	3 1/8
12 1/2	2 11/16
14 1/2	2 7/16
16 1/2	2 1/4
18 1/2	2 1/8
20 1/2	2 1/16
22 1/2	2 1/16

B	
X	Y
0	9
1 13/16	9
2 1/2	7 5/8
3	6 7/8
3 1/2	6 3/16
4 1/2	5 1/4
5 1/2	4 9/16
6 1/2	4
7 1/2	3 9/16
8 1/2	3 1/4
10 1/2	2 13/16
12 1/2	2 1/2
14 1/2	2 5/16
16 1/2	2 3/16
18 1/2	2 1/16
20 1/2	2 1/16
22 1/2	2 1/16



C	
X	Y
0	6
4 7/8	6
5 1/2	5 1/4
6 1/2	4 5/8
7 1/2	4 3/16
8 1/2	3 3/4
9 1/2	3 7/16
10 1/2	3 3/16
11 1/2	2 15/16
12 1/2	2 3/4
14 1/2	2 1/2
16 1/2	2 5/16
18 1/2	2 3/16
20 1/2	2 1/8
22 1/2	2 1/16

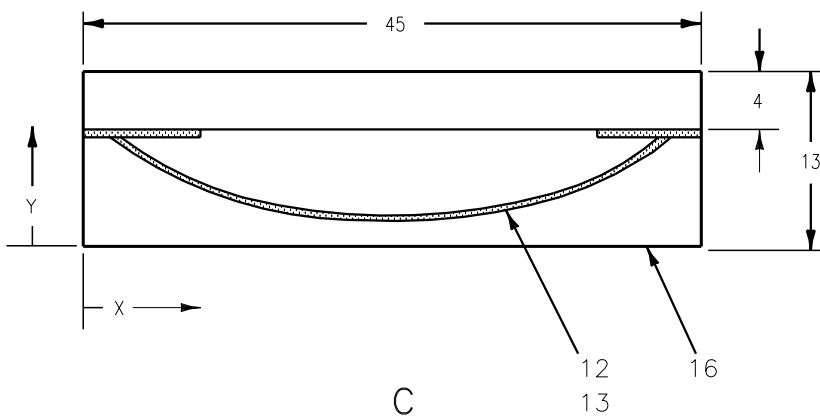


Figure 5. Door 18 Shipping Container (Sheet 2)

BILL OF MATERIALS				
INDEX	QTY	NOMENCLATURE	SIZE	REMARKS
1	1	TOP, SHEATHING	1/4 X 47 X 59.5	
2	4	RUB STRIP	2 X 4 X 47	
3	4	CLEAT	1 X 2 X 59.5	
4	8	CLEAT	1 X 2 X 10	
5	2	SIDE, SHEATHING	1/4 X 14 X 59.5	
6	1	FLOOR, SHEATHING	1 X 45 X 59.5	
7	2	END, SHEATHING	1/4 X 13 X 45	
8	4	CLEAT	1 X 2 X 42	
9	4	CLEAT	1 X 2 X 10	
10	4	CLEAT	1 X 2 X 13	
11	8	CLEAT	1 X 2 X 13	
12	A/R	CUSHION MATERIAL	AS REQUIRED	2
13	A/R	EC-847 ADHESIVE	AS REQUIRED	2
14	1	CONTOUR BOARD, SHEATHING	1 X 13 X 45	
15	1	CONTOUR BOARD, SHEATHING	2 X 13 X 45	
16	1	CONTOUR BOARD, SHEATHING	1 X 13 X 45	

LEGEND

1. DOOR 18 WEIGHT IS 17 POUNDS AND GROSS WEIGHT OF SHIPPING CONTAINER AND DOOR IS APPROXIMATELY 50 POUNDS.

2 CUSHION MATERIAL, POLYETHYLENE, PPP-C-1752, GLUED INTO POSITION WITH EC-847 ADHESIVE.

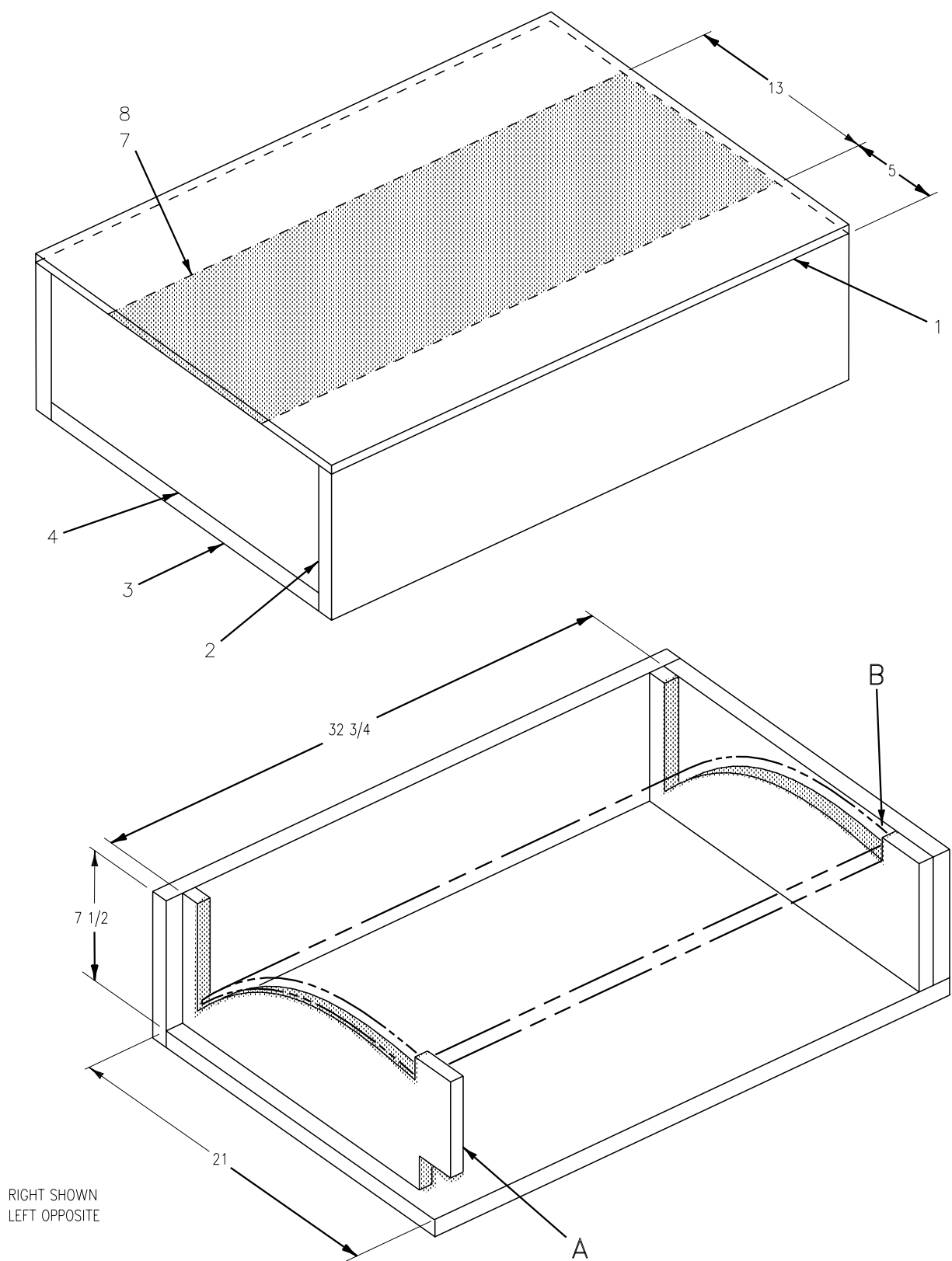
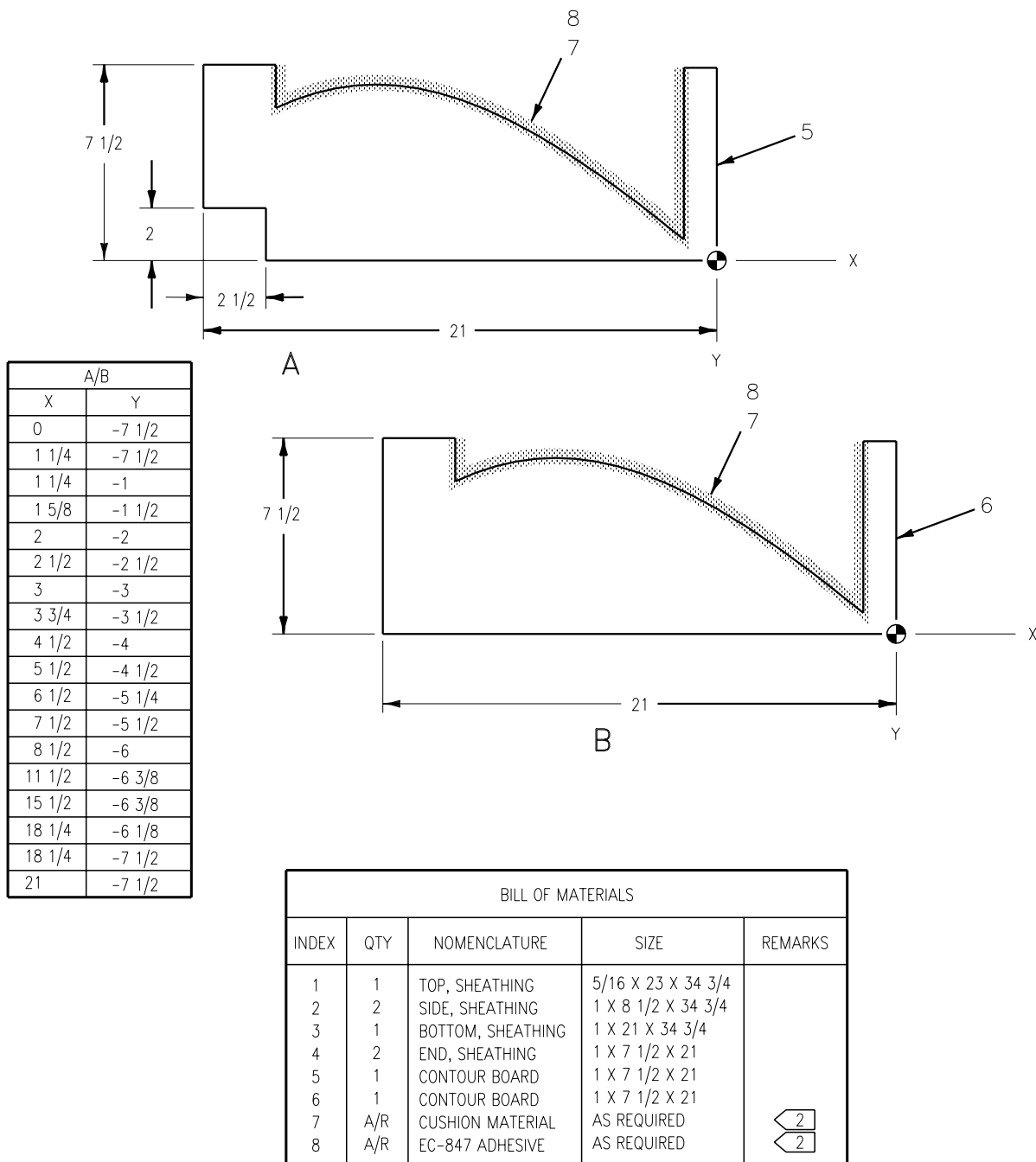


Figure 6. Nose Landing Gear (NLG) Forward Door Shipping Container (Sheet 1)



LEGEND

1. DOOR WEIGHT IS 9 POUNDS AND GROSS WEIGHT OF SHIPPING CONTAINER AND DOOR IS APPROXIMATELY 22 POUNDS.

 CUSHION MATERIAL, POLYETHYLENE, PPP-C-1752, GLUED INTO POSITION WITH EC-847 ADHESIVE.

Figure 6. Nose Landing Gear (NLG) Forward Door Shipping Container (Sheet 2)

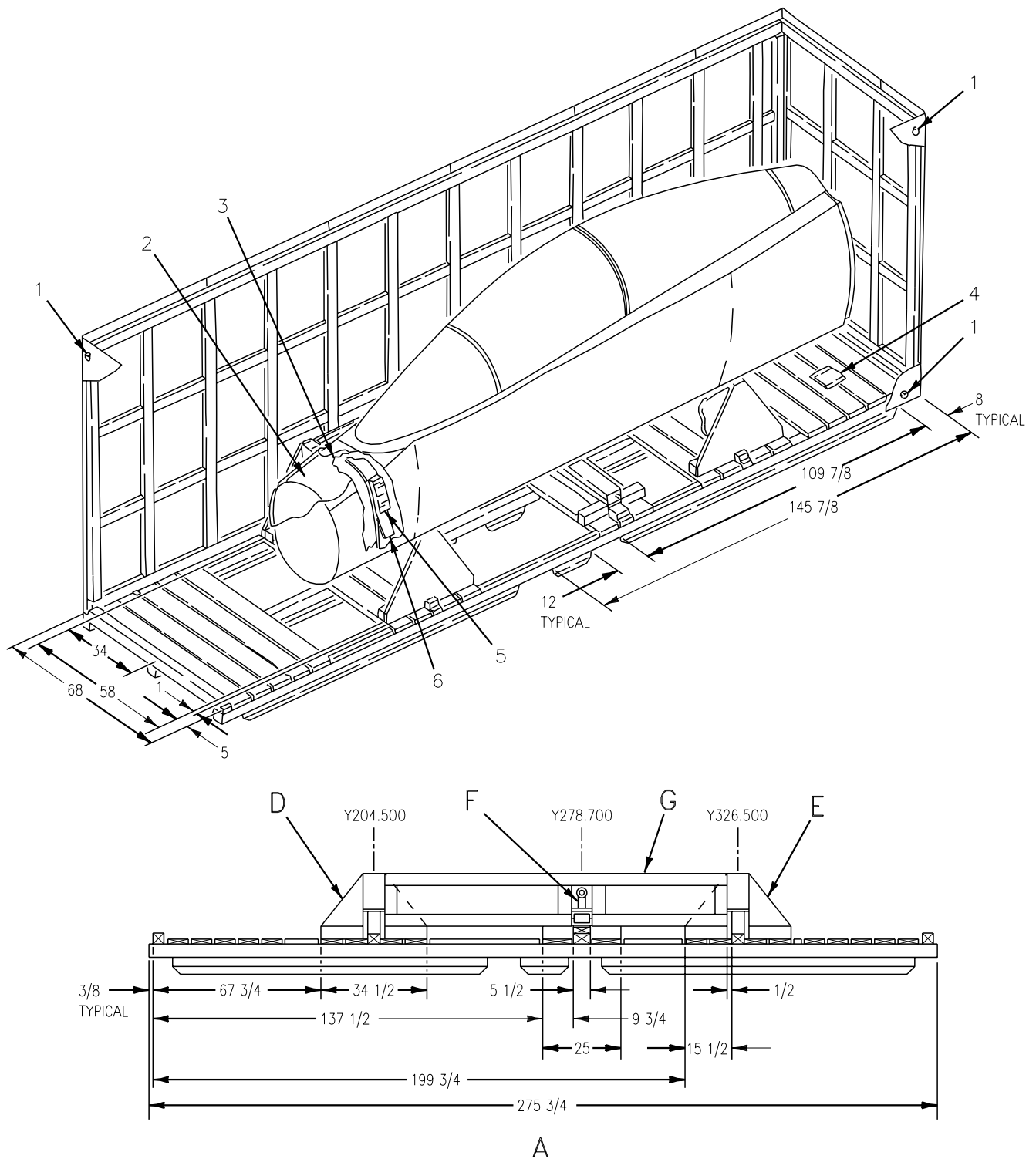


Figure 7. Forward Fuselage Shipping Container (Sheet 1)

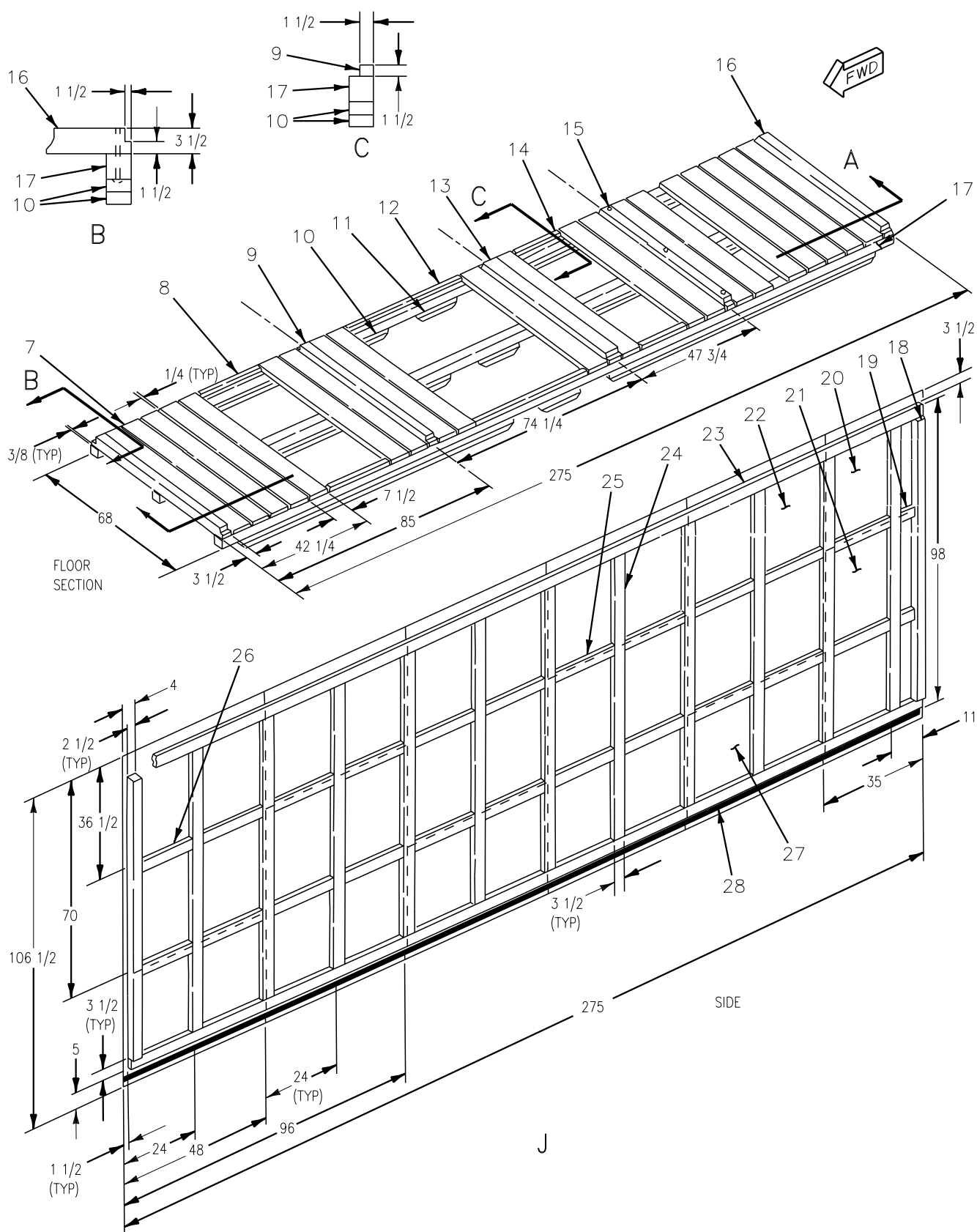


Figure 7. Forward Fuselage Shipping Container (Sheet 2)

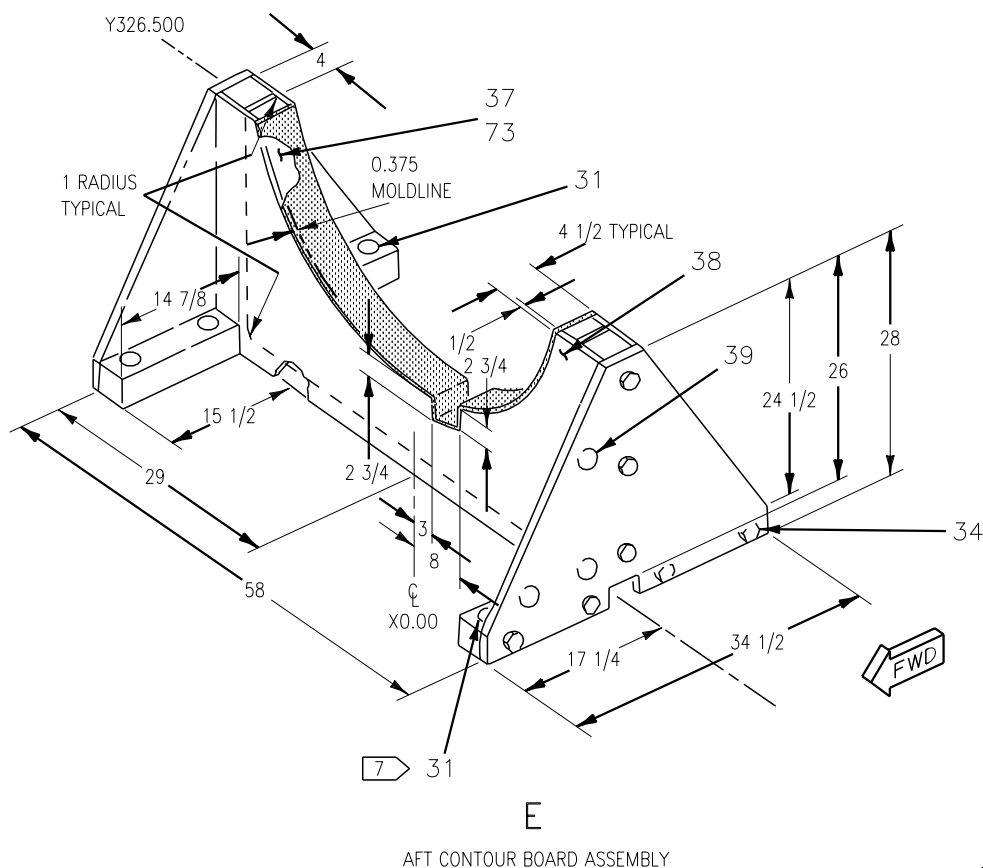
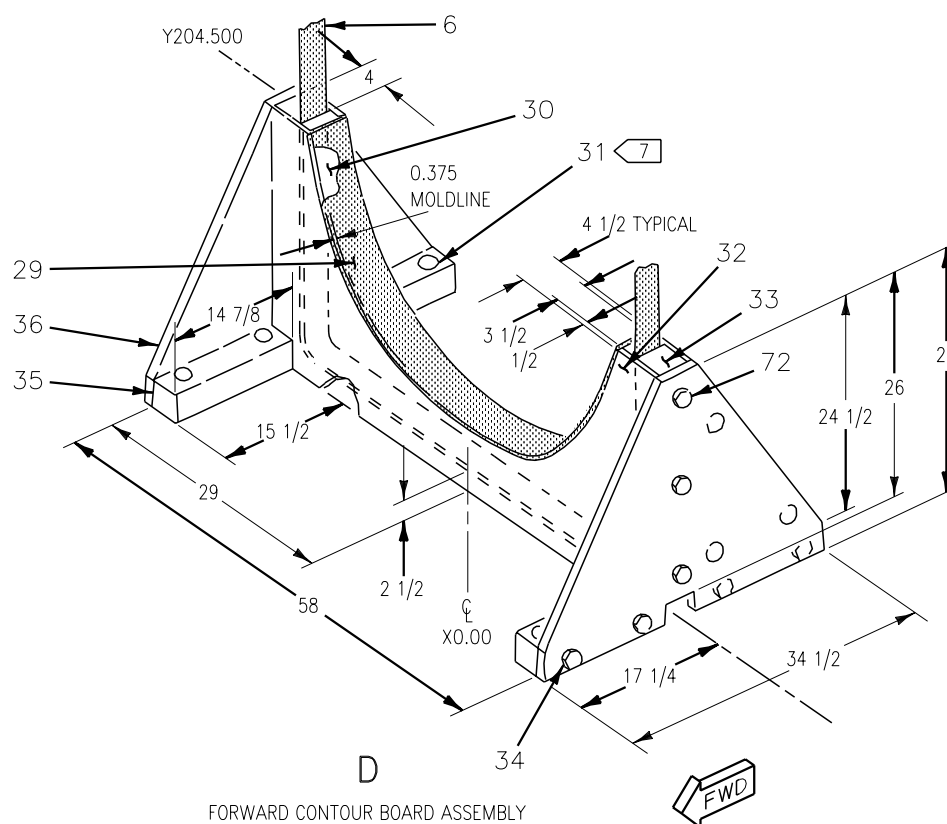


Figure 7. Forward Fuselage Shipping Container (Sheet 3)

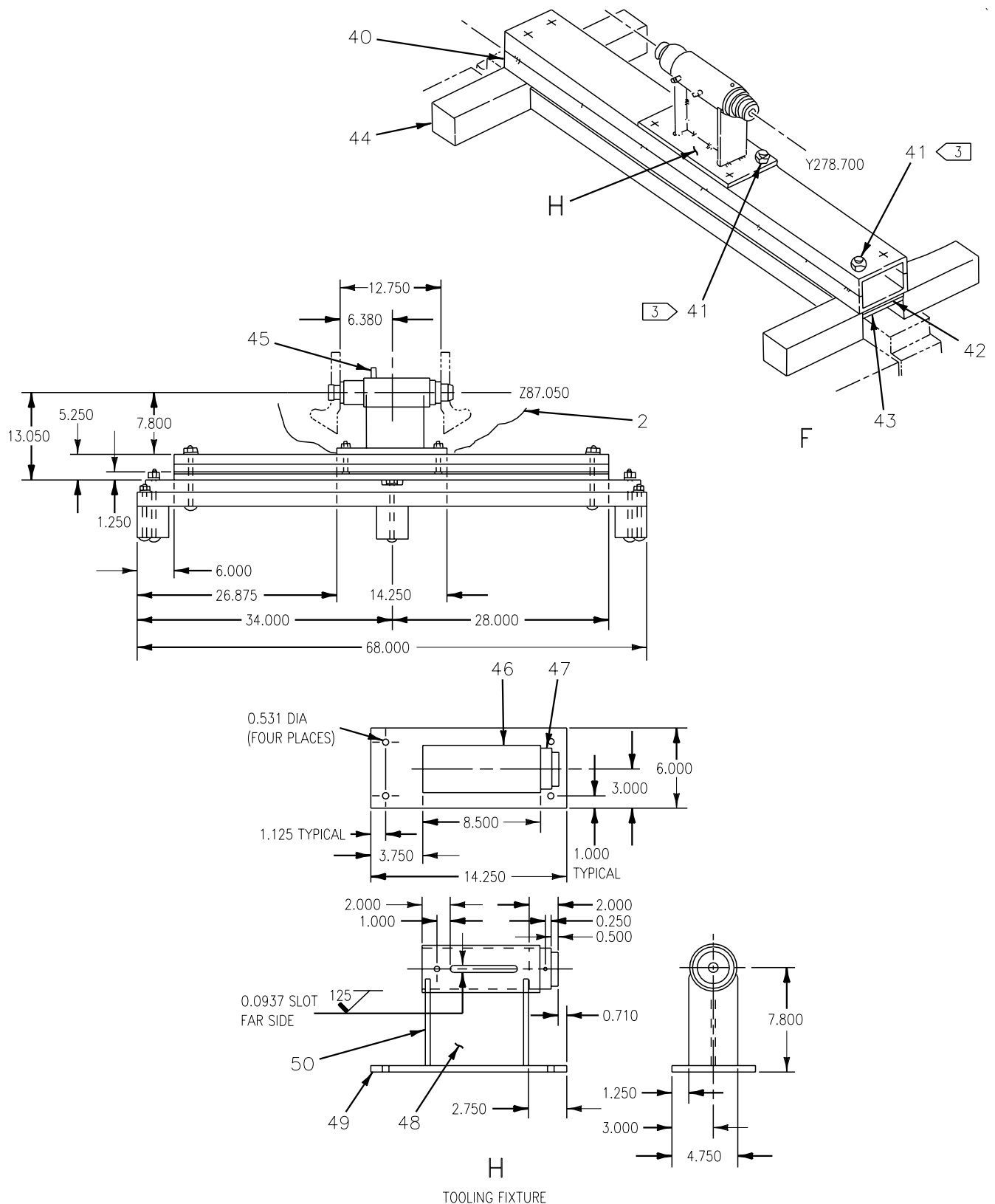


Figure 7. Forward Fuselage Shipping Container (Sheet 4)

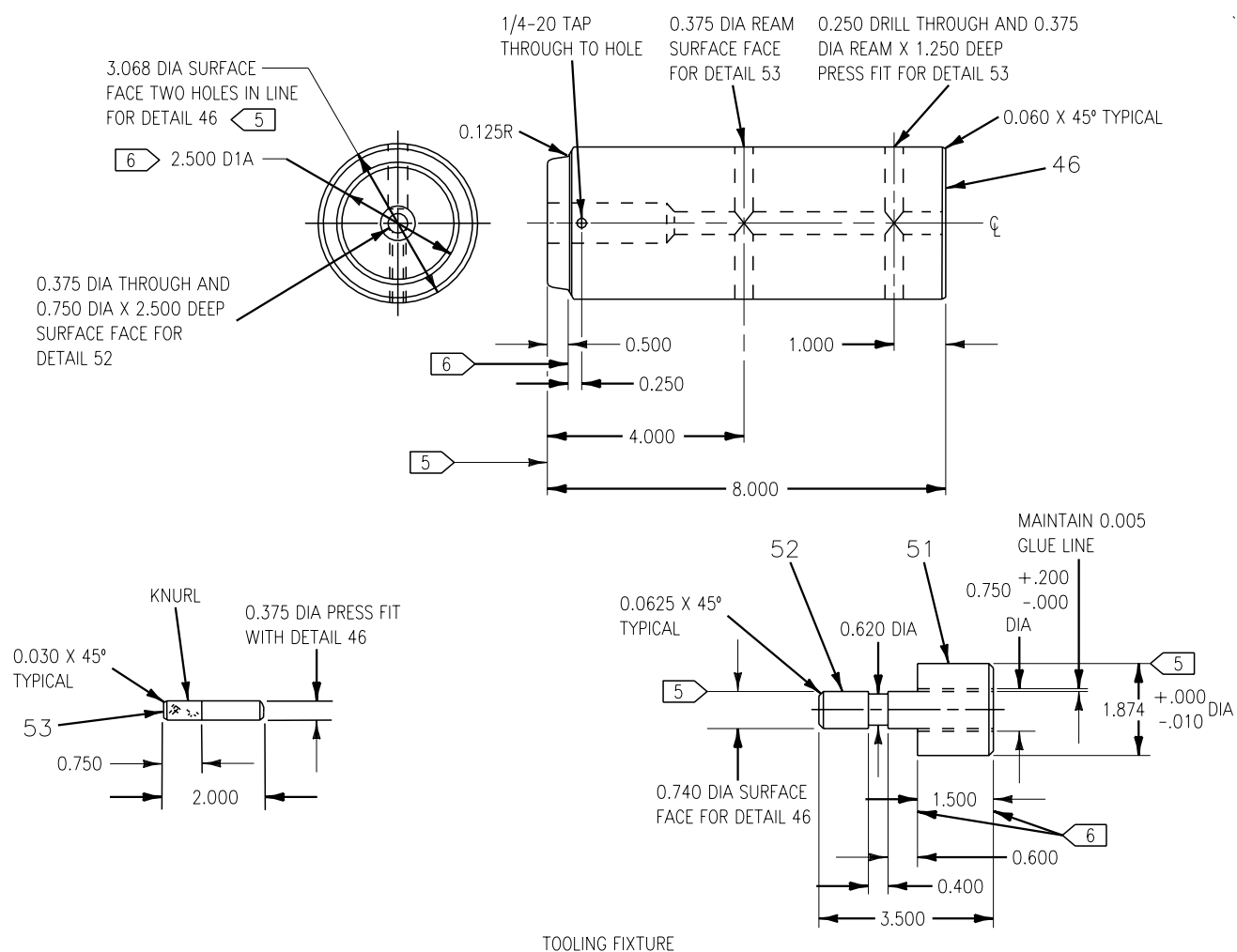


Figure 7. Forward Fuselage Shipping Container (Sheet 5)

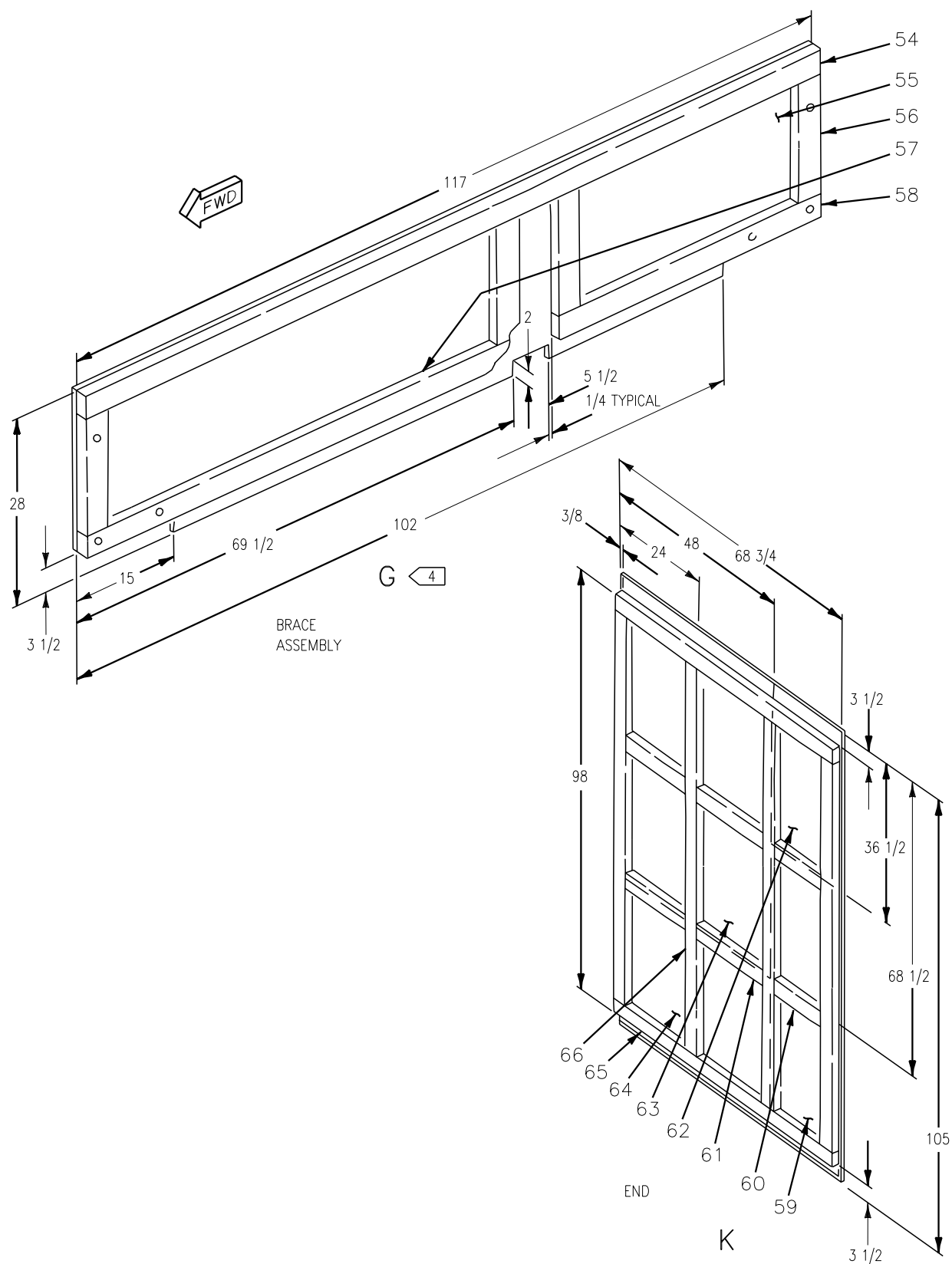


Figure 7. Forward Fuselage Shipping Container (Sheet 6)

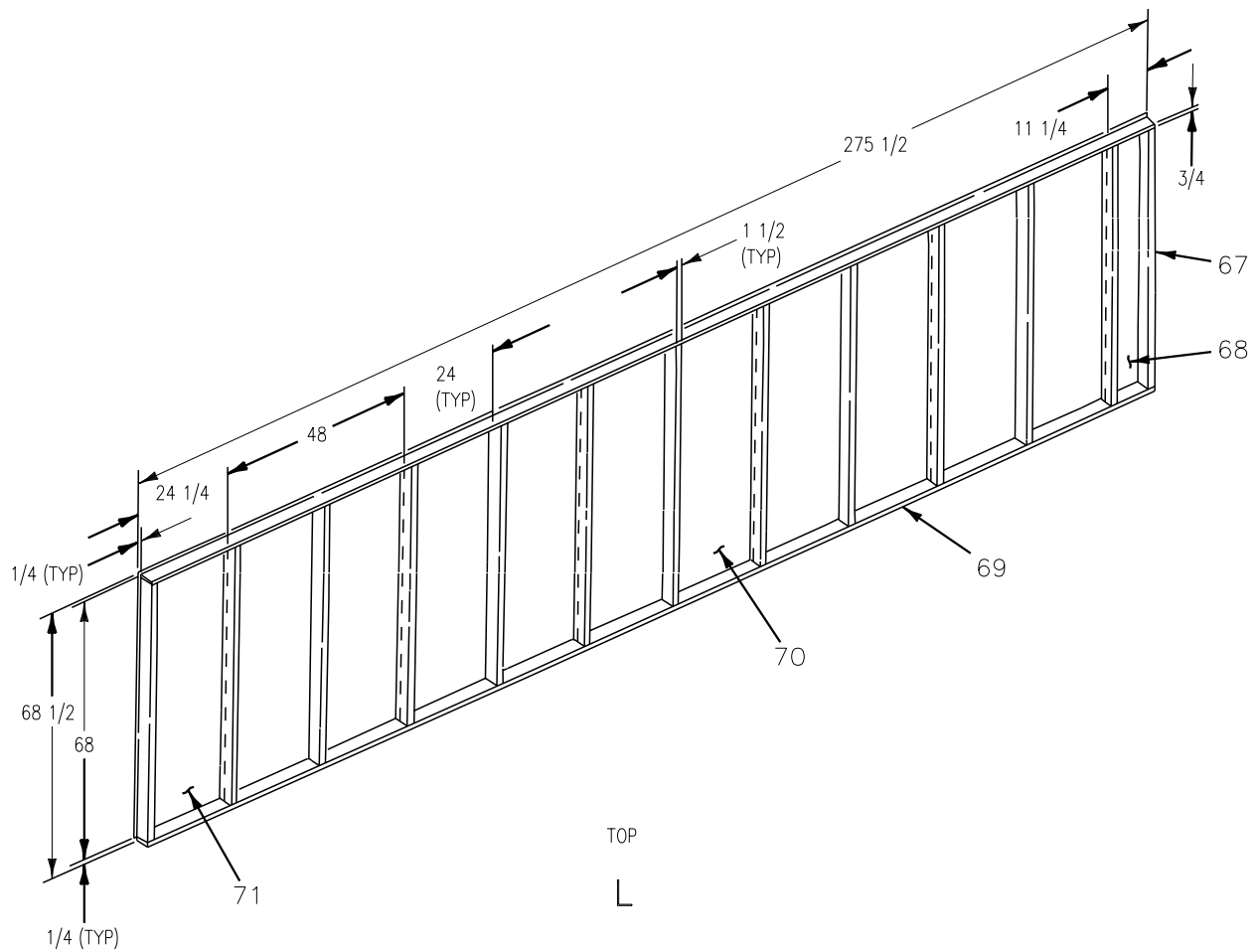


Figure 7. Forward Fuselage Shipping Container (Sheet 7)

BILL OF MATERIALS				
INDEX	QTY	NOMENCLATURE	SIZE	REMARKS
1	A/R	LAG SCREW	1/2 X 3	<div>1</div> <div>MIL-B-131 CLASS 1</div> <div>PPP-C-1752 TYPE 1 CLASS 2</div> <div>MIL-D-3464</div> <div>ANCRA, CORP P/N 43225-10</div> <div>CODE 7D</div>
2	A/R	BARRIER MATERIAL	A/R	
3	A/R	CUSHION MATERIAL	A/R	
4	1200	DESICCANT	UNITS	
5	1	RATCHET BUCKLE	N/A	
6	A/R	NYLON WEBBING	A/R, 0.22 X 2.0	
7	20	FLOOR BOARD	2 X 8 X 68	
8	2	FILLER CLEAT	2 X 2 X 25	
9	2	LOAD CARRYING BRACE	3 1/2 X 3 1/2 X 68	
10	12	RUB STRIP	2 X 4 X 109 7/8	
11	6	RUB STRIP	2 X 4 X 16	
12	2	FILLER CLEAT	2 X 2 X 44	
13	1	LOAD CARRYING BRACE	3 1/2 X 5 1/2 X 68	
14	2	FILLER CLEAT	2 X 2 X 18	
15	18	CARRIAGE BOLT	1/2 X 7 1/2	
6	2	HEADER	4 X 4 X 68	
17	3	SKID	4 X 4 X 275 3/4	
18	4	END CLEAT	3 X 3 X 91	
19	4	HORIZONTAL BRACE	2 X 4 X 5 1/2	
20	2	SHEATHING	3/8 X 35 X 36 1/2	
21	2	SHEATHING	3/8 X 35 X 70	<div>7</div>
22	10	SHEATHING	3/8 X 48 X 70	
23	4	UPPER AND LOWER HORIZONTAL CLEAT	2 X 4 X 272	
24	30	VERTICAL CLEAT	2 X 4 X 91	
25	44	HORIZONTAL CLEAT	2 X 4 X 20 1/2	
26	4	HORIZONTAL CLEAT	2 X 4 X 17 1/4	
27	10	SHEATHING	3/8 X 36 1/2 X 48	
28	A/R	LAG SCREW STRAP	0.050 X 2.0	
29	A/R	CUSHION MATERIAL	1/4 X 4 1/2	
30	2	CONTOUR FILLER	3 1/2 X 25 1/2 X 50	
31	16	CARRIAGE BOLT	3/8 X 5 1/2	<div>1</div> <div>WELDED STRESS RELIEVED</div>
32	2	CONTOUR BOARD SHEATHING	1/2 X 28 X 58	
33	4	BLOCKING	4 X 4 X 26	
34	46	CARRIAGE BOLT	3/8 X 5	
35	8	BLOCKING	4 X 4 X 14 7/8	
36	4	GUSSET	1 X 28 X 34 1/2	
37	2	CONTOUR FILLER	3 1/2 X 25 X 50	
38	2	CONTOUR BOARD SHEATHING	1/2 X 28 X 58	
39	12	CARRIAGE BOLT	3/8 X 5	
40	2	TIE-DOWN, STEEL CHANNEL	0.343 X 2.0 X 6.0 X 56	
41	4	CARRIAGE BOLT	1/2 X 5 1/2	<div>1</div> <div>STD-100V-14-0</div> <div>CORROSION RESISTANT STEEL</div> <div>COLD ROLLED STEEL</div> <div>COLD ROLLED STEEL</div> <div>COLD ROLLED STEEL</div> <div>COLD ROLLED STEEL</div> <div>NYLON ZYTEL 101 POLYMER</div> <div>CORP.</div> <div>COLD ROLLED STEEL</div> <div>COLD ROLLED STEEL</div>
42	2	FILLER	1/4 X 5 1/2 X 56	
43	2	BLOCKING	1 X 5 1/2 X 56	
44	4	BLOCKING	4 X 4 X 9 3/4	
45	2	L PIN FIXTURE WITH CABLE		
46	1	WELDED ASSEMBLY	3.50 DIAMETER X 8.5	
47	1	WELDED ASSEMBLY	3.50 DIAMETER X 2.0	
48	1	WELDED ASSEMBLY, LOAD MEMBER	0.250 X 5.50 X 7.0	
49	1	WELDED ASSEMBLY, PLATE	0.500 X 6.0 X 14.250	
50	2	WELDED ASSEMBLY, END SUPPORT	0.250 X 3.50 X 6.50	
51	2	BONDED ASSEMBLY	2.0 DIAMETER X 1.50	
52	2	BONDED ASSEMBLY	0.750 DIAMETER X 3.50	
53	1	PIN	0.375 DIAMETER X 2.0	
54	2	TOP SUPPORT	2 X 4 X 117	
55	2	SHEATHING, SUPPORT	1 X 28 X 117	
56	8	VERTICAL SUPPORT	2 X 4 X 17 1/2	
57	2	SUPPORT	2 X 4 X 69 1/4	
58	2	SUPPORT	2 X 4 X 41 3/4	

Figure 7. Forward Fuselage Shipping Container (Sheet 8)

59	2	SHEATHING	3/8 X 20 3/4 X 70	
60	4	HORIZONTAL BRACE	2 X 4 X 15 1/8	
61	8	HORIZONTAL BRACE	2 X 4 X 18 3/8	<div>2</div>
62	2	SHEATHING	3/8 X 20 3/4 X 36 1/2	
63	2	SHEATHING	3/8 X 48 X 70	
64	2	SHEATHING	3/8 X 36 1/2 X 48	
65	4	HORIZONTAL CLEAT	2 X 4 X 68 3/4	
66	8	VERTICAL CLEAT	2 X 4 X 91	
67	13	JOIST	2 X 4 X 66 1/4	
68	1	SHEATHING	3/8 X 11 1/4 X 68 1/2	
69	2	SUPPORT, HEADER	1 X 4 X 275	
70	5	SHEATHING	3/8 X 48 X 68 1/2	
71	1	SHEATHING	3/8 X 2 1/4 X 68 1/2	
72	12	LAG SCREW	3/8 X 3 1/2	
73	A/R	EC-847 ADHESIVE	AS REQUIRED	

NOTE:

- 1 USE 3/8-INCH TWIST DRILL TO MAKE PILOT HOLES.
- 2 USE 1/4-INCH TWIST DRILL TO MAKE PILOT HOLES.
- 3 INSTALL BOLTS WITH NUT UP.
- 4 ASSEMBLY, POSITION, DRILL HOLES, AND BOLT INTO POSITION.
- 5 SURFACE FINISH TO RHR-125.
- 6 SURFACE FINISH TO RHR-250.
- 7 FLUSH APPLICATION.

INTERMEDIATE MAINTENANCE

STRUCTURE REPAIR

SHIPPING CONTAINERS

CENTER FUSELAGE

Reference Material

Aircraft Weapons Systems Cleaning and Corrosion Control.....	NAVAIR 01-1A-509
Packaging of Materiel Preservation (Volume 1)	NAVSUP PUB 502

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Record of Applicable Technical Directives

None

1. DESCRIPTION.

2. Shipping containers in this work package are for returning components to a higher level of maintenance or to cognizant supply activity for disposition. They are not meant for long-term storage or adverse shipping conditions. They are to be fabricated using common materials, readily available.

3. GENERAL INFORMATION. See figures 1 through 8.

a. Shipping containers provide protection for components against physical or environmental damage.

b. Shipping containers are constructed of wood or plywood with wood cleats, rub strips, and skids.

c. Interior contour boards are made from wood or plywood with cushioning to protect component. Contour boards secure component inside shipping container and protect component from damage caused by movement.

d. Damaged components may require additional boards to prevent further damage.

e. Loose hardware should be bagged and secured in shipping container.

4. PRESERVATION OF COMPONENTS.

Support Equipment Required

None

Materials Required

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number	Nomenclature
MIL-L-3150	Lubricating Oil, Preservative Oil
MIL-D-3464 TYPE 1	Desiccant
MIL-B-121 TY1GRA CL1	Barrier Material
MIL-T-22085	Adhesive Tape, Preservation and Sealing Tape
A-A-883, TYPE 1	Pressure Sensitive Tape, Masking Tape

a. Clean foreign material from component before preserving (NAVAIR 01-1A-509 and NAVSUP PUB 502).

b. Painted surfaces require no special coating.

c. Unpainted surfaces, nicks, scratches, or gouges in painted surfaces shall be coated with lubricating oil.

d. All hinges shall be coated with lubricating oil.

e. Put bags of desiccant into cavities and cover cavities with barrier material, taped in place with adhesive tape.

5. PROCEDURES.

6. MAIN LANDING GEAR (MLG) INBOARD DOOR SHIPPING CONTAINER. See figure 1.

Support Equipment Required

None

Materials Required

See Figure 1.

7. **Fabrication of Shipping Container and Installation of MLG Inboard Door.** The MLG inboard door shipping container is fabricated and MLG inboard door is installed as shown in figure 1.

8. **MLG OUTBOARD DOOR SHIPPING CONTAINER.** See figure 2.

Support Equipment Required

None

Materials Required

See Figure 2.

9. **Fabrication of Shipping Container and Installation of MLG Outboard Door.** The MLG outboard door shipping container is fabricated and the MLG outboard door is installed as shown in figure 2.

10. **MLG FORWARD DOOR SHIPPING CONTAINER.** See figure 3.

Support Equipment Required

None

Materials Required

See Figure 3.

11. **Fabrication of Shipping Container and Installation of MLG Forward Door.** The MLG forward door shipping container is fabricated and MLG forward door is installed as shown in figure 3.

12. **DOOR 26 SHIPPING CONTAINER.** See figure 4.

Support Equipment Required

None

Materials Required

See Figure 4.

13. **Fabrication of Shipping Container and Installation of Door 26.** The door 26. shipping container is fabricated and door is installed as shown in figure 4.

14. **DOOR 31 SHIPPING CONTAINER.** See figure 5.

Support Equipment Required

None

Materials Required

See Figure 5.

15. **Fabrication of Shipping Container and Installation of Door 31.** The door 31 shipping container is fabricated and door is installed as shown in figure 5.

16. **DOOR 40 SHIPPING CONTAINER.** See figure 6.

Support Equipment Required

None

Materials Required

See Figure 6.

17. **Fabrication of Shipping Container and Installation of Door 40.** The door 40 shipping container is fabricated and door is installed as shown in figure 6.

18. **DOOR 43 SHIPPING CONTAINER.** See figure 7.

Support Equipment Required

None

Materials Required

See Figure 7.

19. **Fabrication of Shipping Container and Installation of Door 43.** The door 43 shipping container is fabricated and is installed as shown in figure 7.

20. **DOOR 49 SHIPPING CONTAINER.** See figure 8.

Support Equipment Required

None

Materials Required

See Figure 8.

21. **Fabrication of Shipping Container and Installation of Door 49.** The door 49 shipping container is fabricated and door is installed as shown in figure 8.

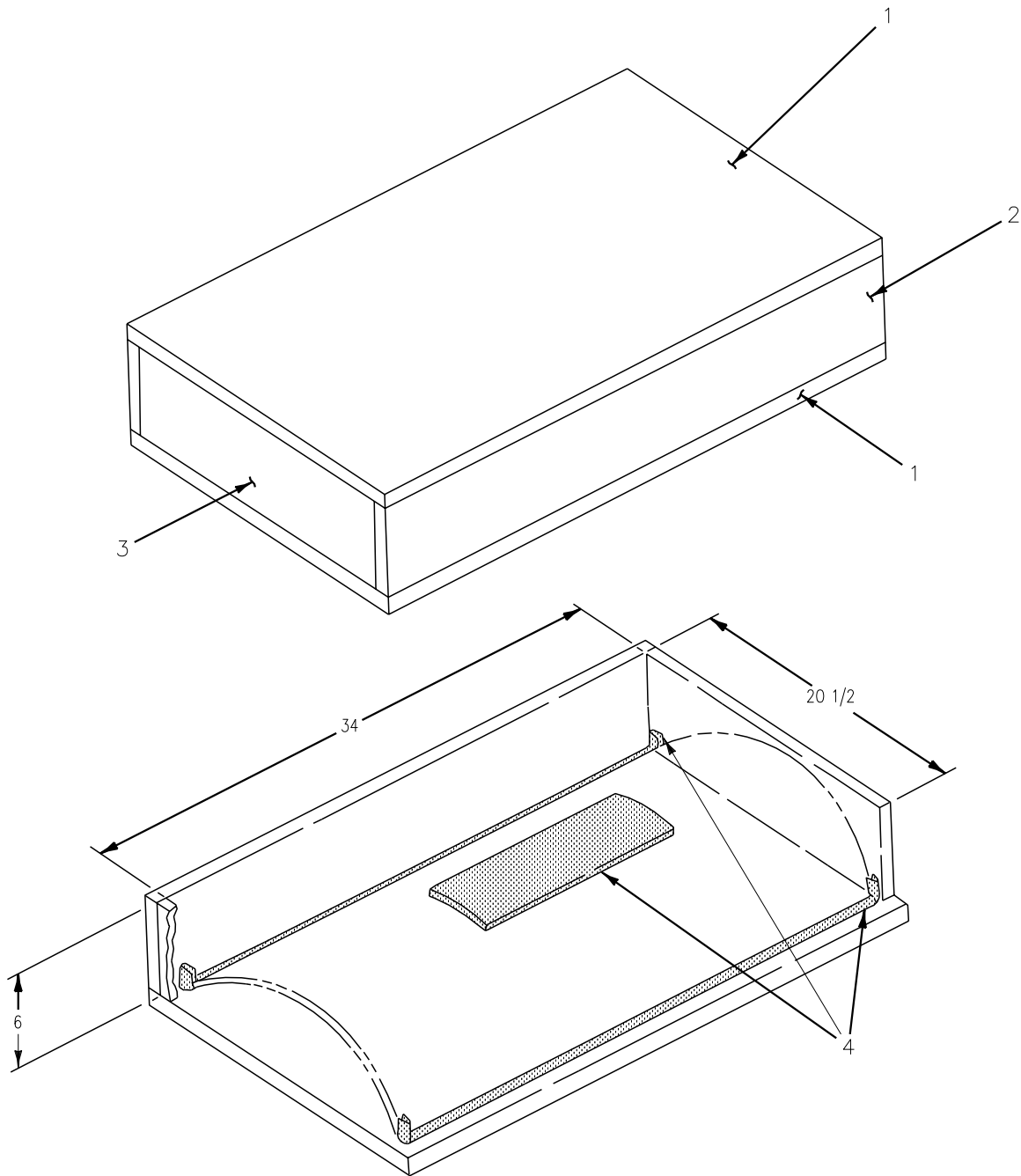


Figure 1. MLG Inboard Door Shipping Container (Sheet 1)

BILL OF MATERIALS				
ITEM	QTY	NOMENCLATURE	SIZE	REMARKS
1	2	TOP AND BOTTOM, SHEATHING	1 X 22 1/2 X 36	<div>2</div>
2	2	SIDE, SHEATHING	1 X 6 X 36	
3	2	END, SHEATHING	1 X 6 X 20 1/2	
4	A/R	CUSHION MATERIAL	AS REQUIRED	

LEGEND

1. MLG INBOARD DOOR WEIGHT IS 12.5 POUNDS AND GROSS WEIGHT OF SHIPPING CONTAINER AND MLG INBOARD DOOR IS APPROXIMATELY 30 POUNDS.

2

 CUSHION MATERIAL, POLYETHYLENE, PPP-C-1752

Figure 1. MLG Inboard Door Shipping Container (Sheet 2)

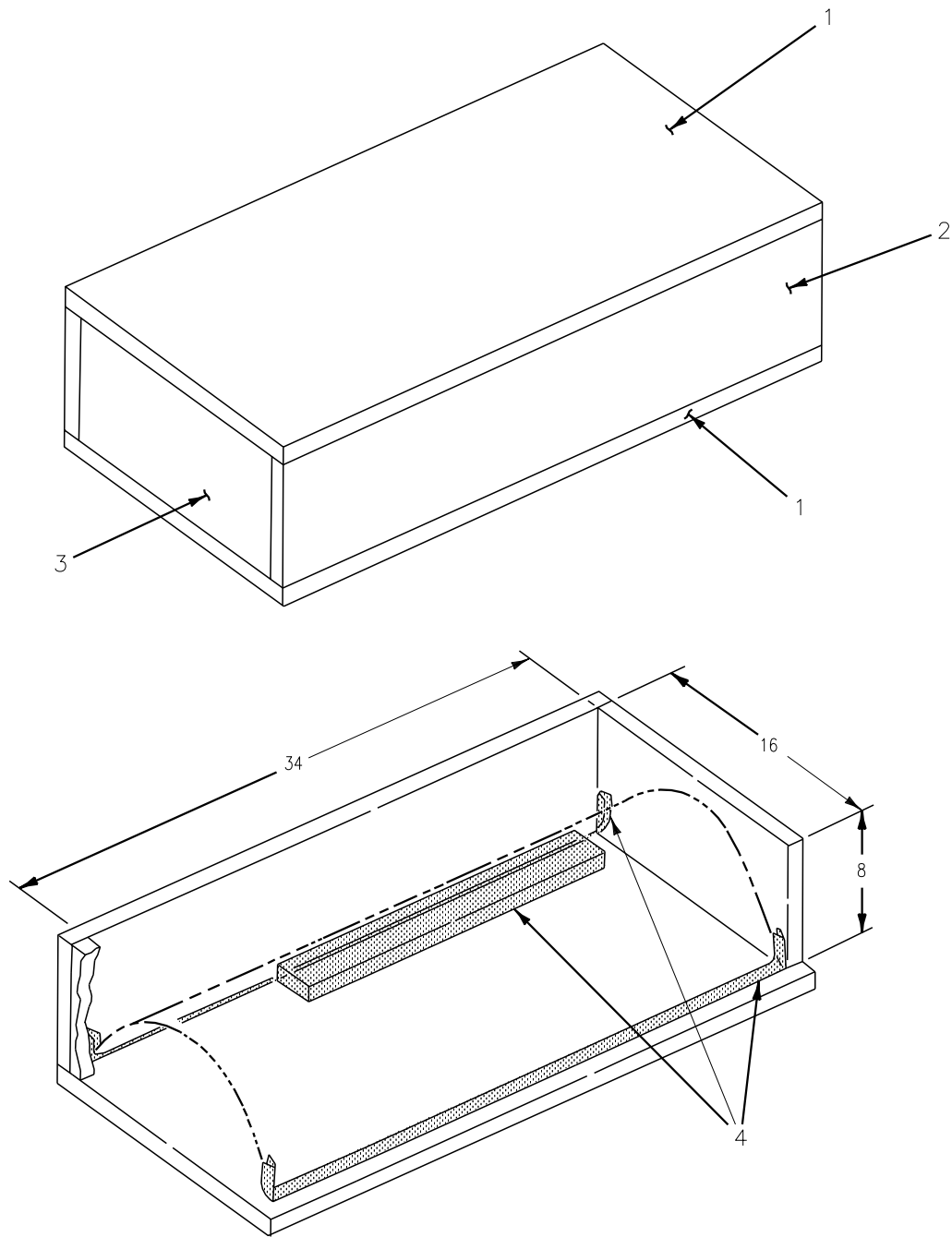


Figure 2. MLG Outboard Door Shipping Container (Sheet 1)

BILL OF MATERIALS				
ITEM	QTY	NOMENCLATURE	SIZE	REMARKS
1	2	TOP AND BOTTOM, SHEATHING	1 X 18 X 36	<div>2</div>
2	2	SIDE, SHEATHING	1 X 8 X 36	
3	2	END, SHEATHING	1 X 8 X 16	
4	A/R	CUSHION MATERIAL	AS REQUIRED	

LEGEND

1. MLG OUTBOARD DOOR WEIGHT IS 10.5 POUNDS AND GROSS WEIGHT OF SHIPPING CONTAINER AND MLG OUTBOARD DOOR IS APPROXIMATELY 28 POUNDS.

2

 CUSHION MATERIAL, POLYETHYLENE, PPP-C-1752.

Figure 2. MLG Outboard Door Shipping Container (Sheet 2)

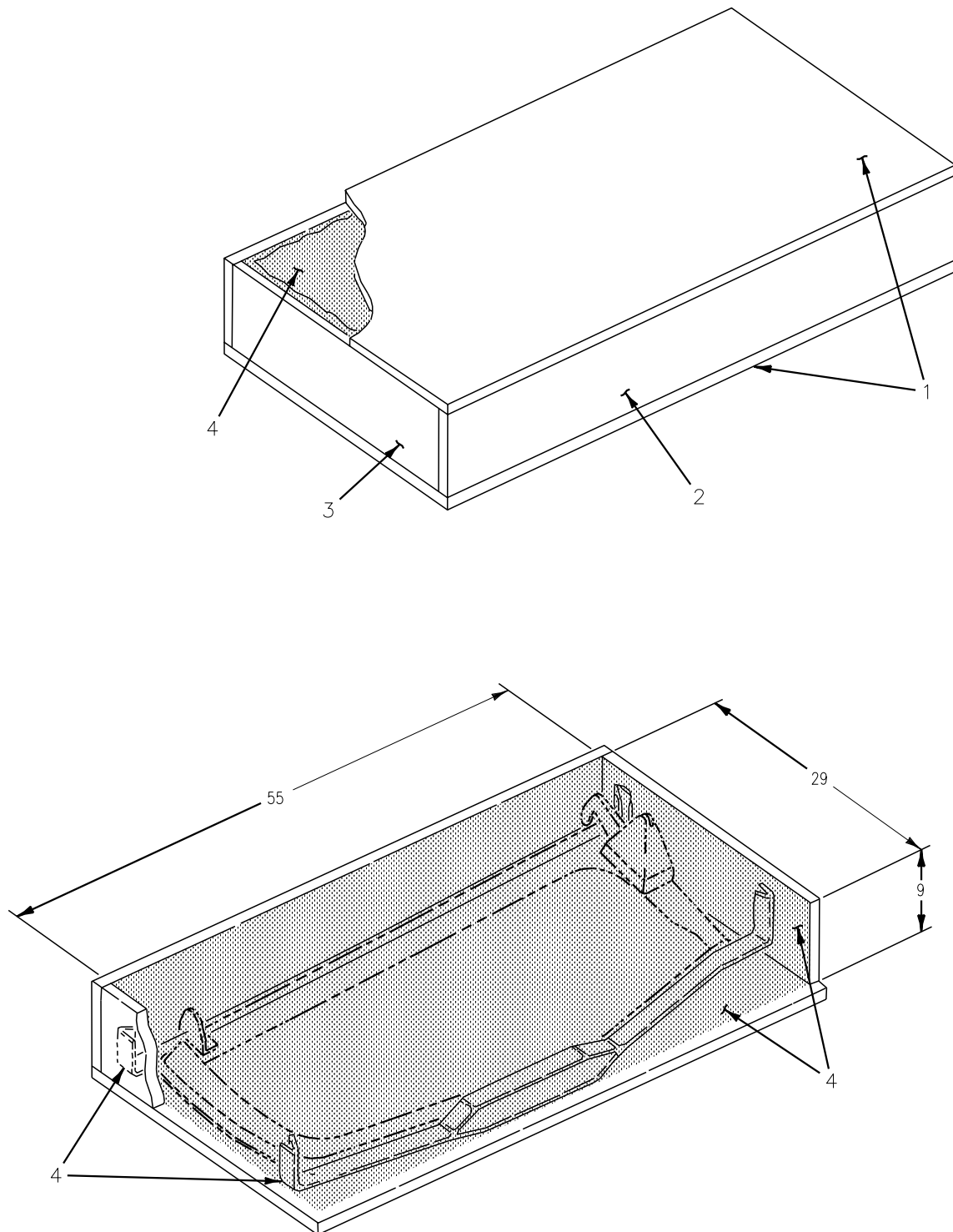


Figure 3. MLG Forward Door Shipping Container (Sheet 1)

BILL OF MATERIALS				
ITEM	QTY	NOMENCLATURE	SIZE	REMARKS
1	2	TOP AND BOTTOM, SHEATHING	1 X 31 X 57	<div>2</div>
2	2	SIDE, SHEATHING	1 X 9 X 57	
3	2	END, SHEATHING	1 X 9 X 29	
4	A/R	CUSHION MATERIAL	AS REQUIRED	

LEGEND

1. MLG FORWARD DOOR WEIGHT IS 24 POUNDS AND GROSS WEIGHT OF SHIPPING CONTAINER AND MLG FORWARD DOOR IS APPROXIMATELY 48 POUNDS.

2

 CUSHION MATERIAL, POLYETHYLENE, PPP-C-1752.

Figure 3. MLG Forward Door Shipping Container (Sheet 2)

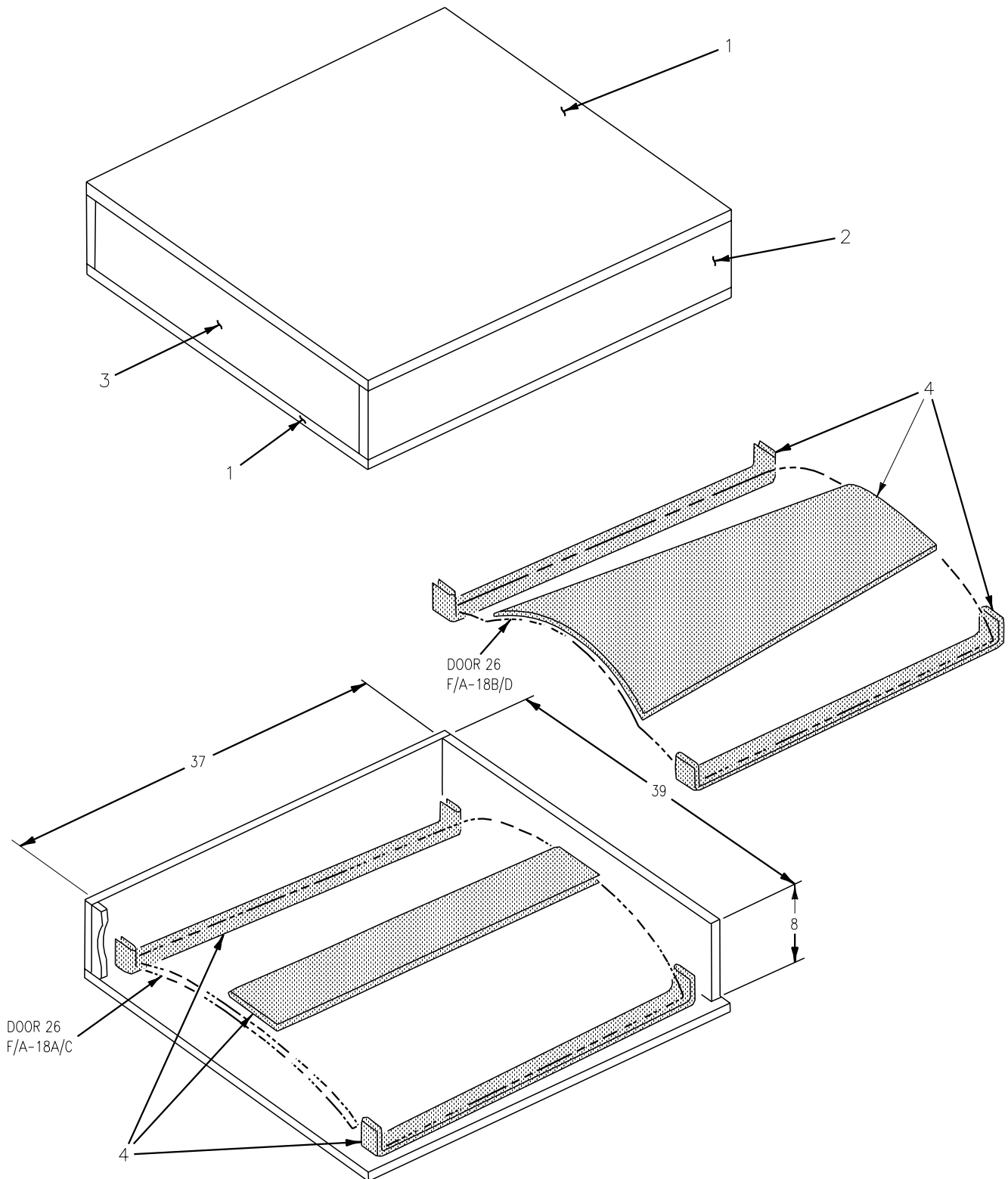


Figure 4. Door 26 Shipping Container (Sheet 1)

BILL OF MATERIALS				
ITEM	QTY	NOMENCLATURE	SIZE	REMARKS
1	2	TOP AND BOTTOM, SHEATHING	1 X 39 X 41	<div>2</div>
2	2	SIDE, SHEATHING	1 X 8 X 39	
3	2	END, SHEATHING	1 X 8 X 39	
4	A/R	CUSHION MATERIAL	AS REQUIRED	

LEGEND

1. DOOR 18 WEIGHT IS 11 POUNDS AND GROSS WEIGHT OF SHIPPING CONTAINER AND DOOR 18 IS APPROXIMATELY 46 POUNDS.

2

 CUSHION MATERIAL, POLYETHYLENE, PPP-C-1752.

Figure 4. Door 26 Shipping Container (Sheet 2)

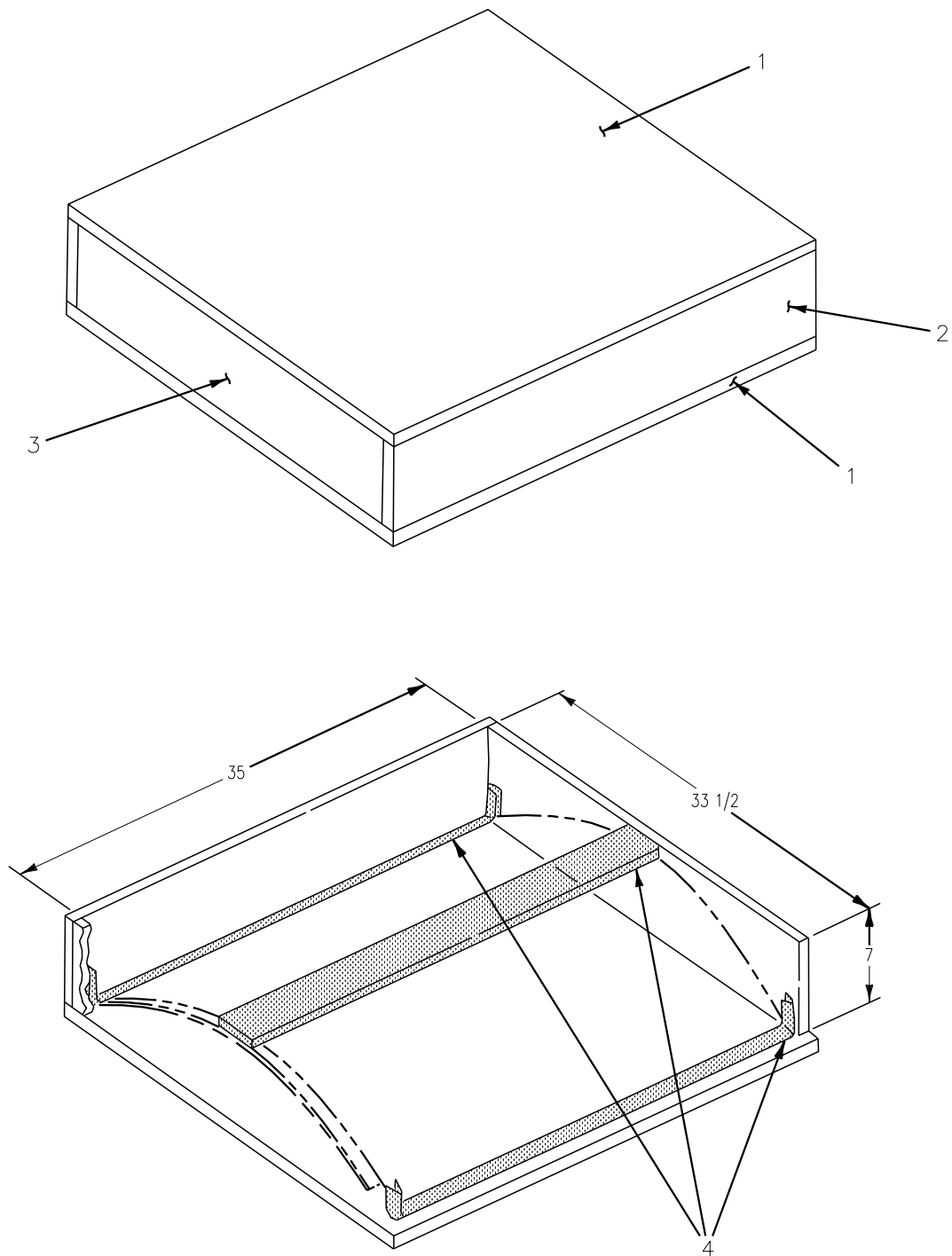


Figure 5. Door 31 Shipping Container (Sheet 1)

BILL OF MATERIALS				
ITEM	QTY	NOMENCLATURE	SIZE	REMARKS
1	2	TOP AND BOTTOM, SHEATHING	1 X 35 1/2 x 37	<div>2</div>
2	2	SIDE, SHEATHING	1 X 7 X 37	
3	2	END, SHEATHING	1 X 7 X 33 1/2	
4	A/R	CUSHION MATERIAL	AS REQUIRED	

LEGEND

1. DOOR 31 WEIGHT IS 9.5 POUNDS AND GROSS WEIGHT O SHIPPING CONTAINER AND DOOR 31 IS APPROXIMATELY 48 POUNDS.

2

 CUSHION MATERIAL, POLYETHYLENE, PPP-C-1752.

Figure 5. Door 31 Shipping Container (Sheet 2)

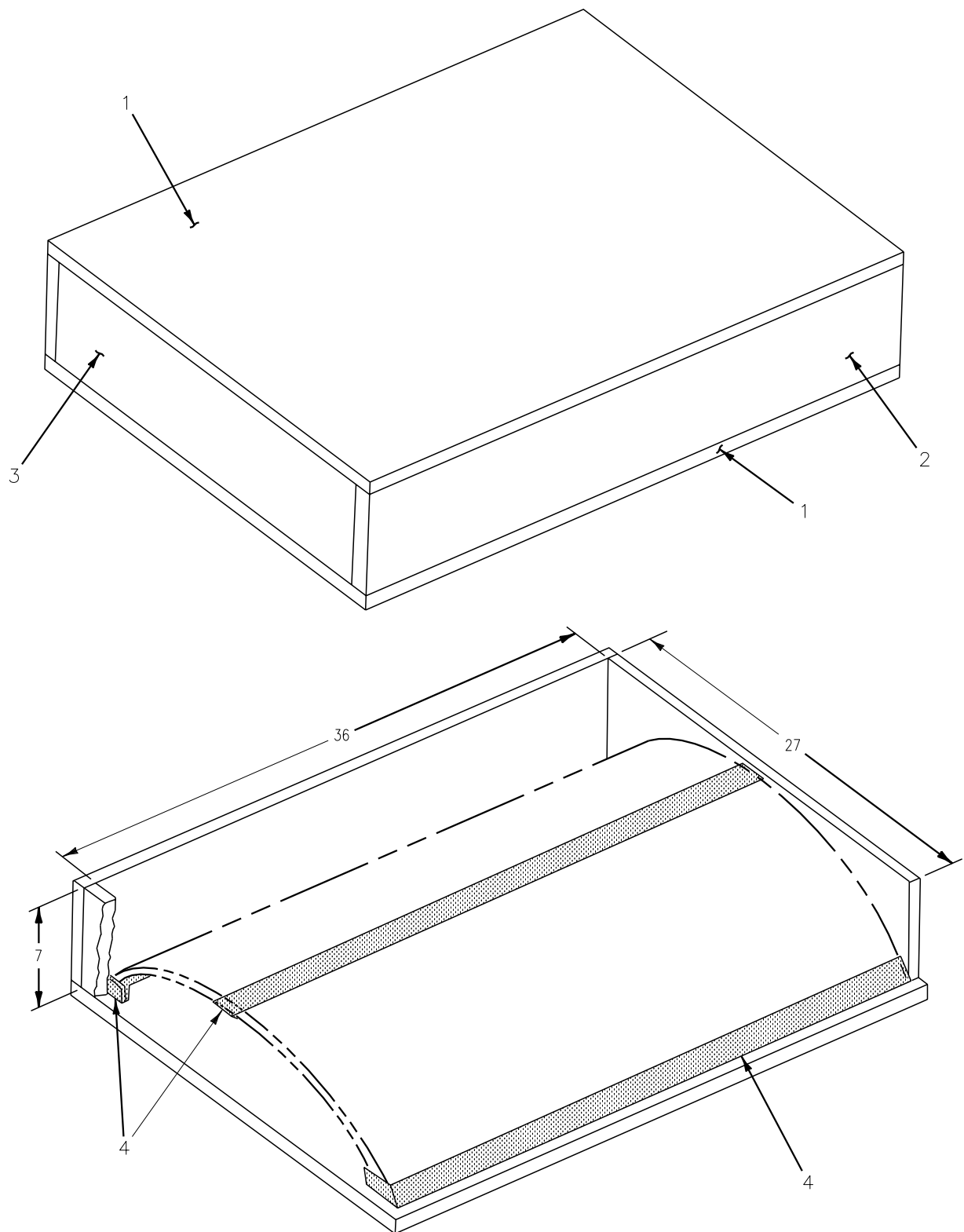


Figure 6. Door 40 Shipping Container (Sheet 1)

BILL OF MATERIALS				
ITEM	QTY	NOMENCLATURE	SIZE	REMARKS
1	2	TOP AND BOTTOM, SHEATHING	1 X 29 1/2 X 38	<div>2</div>
2	2	SIDE, SHEATHING	1 X 7 X 38	
3	2	END, SHEATHING	1 X 7 X 26 1/2	
4	A/R	CUSHION MATERIAL	AS REQUIRED	

LEGEND

1. DOOR 40 WEIGHT IS 7 POUNDS AND GROSS WEIGHT OF SHIPPING CONTAINER AND DOOR 40 IS APPROXIMATELY 26 POUNDS.

2

 CUSHION MATERIAL, POLYETHYLENE, PPP-C-1752.

Figure 6. Door 40 Shipping Container (Sheet 2)

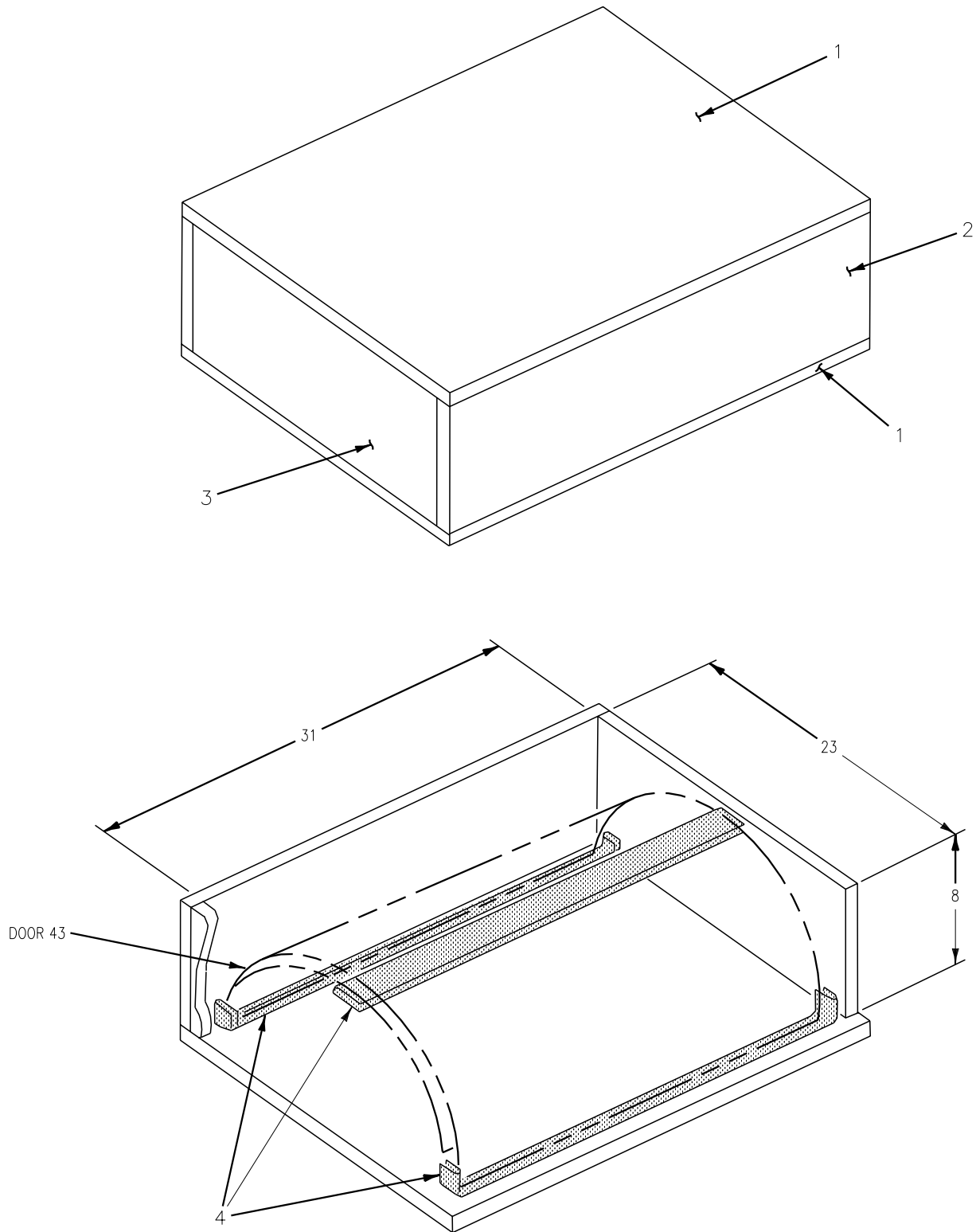


Figure 7. Door 43 Shipping Container (Sheet 1)

BILL OF MATERIALS				
ITEM	QTY	NOMENCLATURE	SIZE	REMARKS
1	2	TOP AND BOTTOM, SHEATHING	1 X 25 X 33	<div>◀ 2</div>
2	2	SIDE, SHEATHING	1 X 8 X 33	
3	2	END, SHEATHING	1 X 8 X 23	
4	A/R	CUSHION MATERIAL	AS REQUIRED	

LEGEND

- 1. DOOR 43 WEIGHT IS 5.5 POUNDS AND GROSS WEIGHT OF SHIPPING CONTAINER AND DOOR 43 IS APPROXIMATELY 26 POUNDS.
- 2. CUSHION MATERIAL, POLYETHYLENE, PPP-C-1752.

Figure 7. Door 43 Shipping Container (Sheet 2)

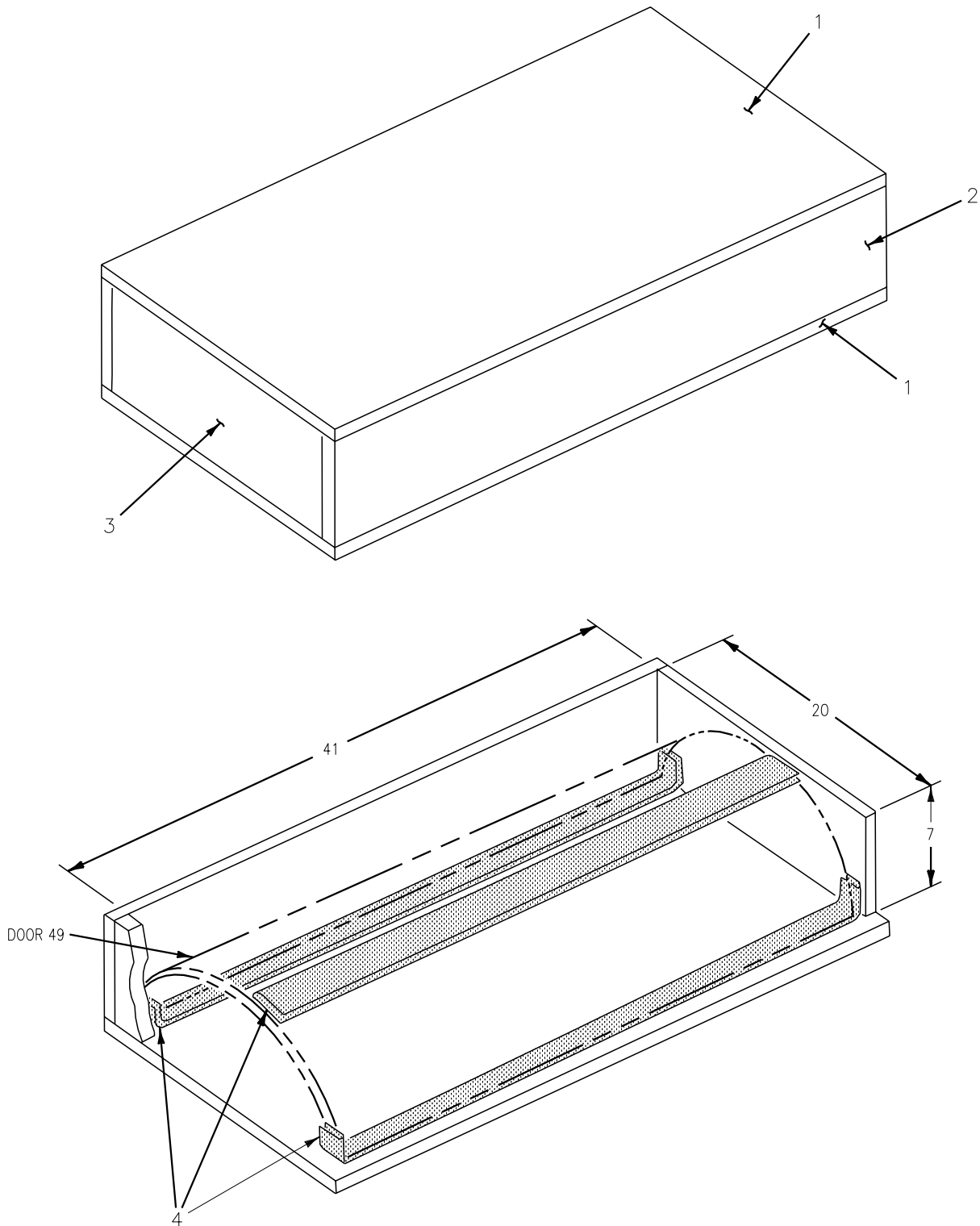


Figure 8. Door 49 Shipping Container (Sheet 1)

BILL OF MATERIALS				
ITEM	QTY	NOMENCLATURE	SIZE	REMARKS
1	2	TOP AND BOTTOM, SHEATHING	1 X 22 X 43	<div>2</div>
2	2	SIDE, SHEATHING	1 X 7 X 43	
3	2	END, SHEATHING	1 X 7 X 20	
4	A/R	CUSHION MATERIAL	AS REQUIRED	

LEGEND

1. DOOR 49 WEIGHT IS 6 POUNDS AND GROSS WEIGHT OF SHIPPING CONTAINER AND DOOR 49 IS APPROXIMATELY 26 POUNDS.

2

 CUSHION MATERIAL, POLYETHYLENE, PPP-C-1752.

Figure 8. Door 49 Shipping Container (Sheet 2)

INTERMEDIATE MAINTENANCE**STRUCTURE REPAIR****SHIPPING CONTAINERS****AFT FUSELAGE****Reference Material**

Aircraft Weapons Systems Cleaning and Corrosion Control.....	NAVAIR 01-1A-509
Packaging of Materiel Preservation (Volume 1)	NAVSUP PUB 502
Integrated Flight Controls.....	A1-F18AC-570-300
Stabilator (84MPS529 or 84MPT530) Electronic Flight Control System.....	WP021 00

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Horizontal Stabilator Shipping Container	3
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Speed Brake Shipping Container	2
Vertical Stabilizer Shipping Container	5

Record of Applicable Technical Directives

None

1. DESCRIPTION.

2. Shipping containers in this work package are for returning components to higher level of maintenance or to cognizant supply activity for disposition. They are not meant for long-term storage or adverse shipping conditions. They are to be fabricated using common materials, readily available.

3. **GENERAL INFORMATION.** See figures 1 through 6.

a. Shipping containers provide protection for components against physical or environmental damage.

b. Shipping containers are constructed of wood or plywood with wood cleats, rub strips, and skids.

c. Interior contour boards are made from wood or plywood with cushioning to protect component. Contour boards secure component inside shipping container and protect component from damage caused by movement.

d. Damaged components may require additional boards to prevent further damage.

e. Loose hardware should be bagged and secured in shipping container.

4. PRESERVATION OF COMPONENTS.

Support Equipment Required

None

Materials Required

NOTE

Alternate item specifications or part numbers are shown indented.

Specification or Part Number

Nomenclature

MIL-L-3150	Lubricating Oil, Preservative Oil
MIL-D-3464 TYPE 1	Desiccant
MIL-B-121 TY1GRA CL1	Barrier Material
MIL-T-22085	Adhesive Tape, Preservation and Sealing Tape
A-A-883, TYPE 1	Pressure Sensitive Tape, Masking Tape

a. Clean foreign material from component before preserving (NAVAIR 01-1A-509 and NAVSUP PUB 502).

b. Painted surfaces require no special coating.

c. Unpainted surfaces, nicks, scratches, or gouges in painted surfaces shall be coated with lubricating oil.

d. All hinges shall be coated with lubricating oil.

e. Put bags of desiccant into cavities and cover cavities with barrier material taped in place with adhesive tape.

5. PROCEDURES.

6. RUDDER SHIPPING CONTAINER.

Support Equipment Required

None

Materials Required

See Figure 1.

7. **Fabrication of Shipping Container and Installation of Rudder.** Fabricate shipping container and install rudder as shown in figure 1.

8. SPEED BRAKE SHIPPING CONTAINER.

Support Equipment Required

None

Materials Required

See Figure 2.

9. **Fabrication of Shipping Container and Installation of Speed Brake.** Fabricate shipping container and install speed brake as shown in figure 2.

10. FORWARD ENGINE BAY DOOR SHIPPING CONTAINER.

Support Equipment Required

None

Materials Required

See Figure 3.

11. **Fabrication of Shipping Container and Installation of Forward Engine Bay Door.**

Fabricate shipping container and install forward engine bay door as shown in figure 3.

12. CENTER ENGINE BAY DOOR SHIPPING CONTAINER.

Support Equipment Required

None

Materials Required

See Figure 4.

13. Fabrication of Shipping Container and Installation of Center Engine Bay Door. Fabricate shipping container and install center engine bay door as shown in figure 4.

14. AFT ENGINE BAY DOOR SHIPPING CONTAINER.

Support Equipment Required

None

Materials Required

See Figure 5.

15. Fabrication of Shipping Container and Installation of Aft Engine Bay Door. Fabricate shipping container and install aft engine bay door as shown in figure 5.

16. HORIZONTAL STABILATOR SHIPPING CONTAINER.

Support Equipment Required

None

Materials Required

See Figure 6.

17. Fabrication of Shipping Container and Installation of Horizontal Stabilator. Fabricate shipping container and install horizontal stabilator as shown in figure 6 and per procedures below:

a. Fabricate floor section of shipping container per substeps below:

(1) Nail skids (11) to floor sections (23) and (25).

(2) Attach headers (28) to floor sections (23) and (25) using carriage bolts (30).

(3) Attach supports (24) to joint of floor sections (23) and (25) using carriage bolts (31).

(4) Attach supports (22) to floor sections (23) and (25) using carriage bolts (30).

(5) Attach support (26) to floor section (25) using carriage bolts (31).

(6) Attach clamp (40) to floor section (23) using carriage bolts (30).

(7) Nail rub strips (8) and (10) to skids (11).

(8) Attach support (39) to clamp (40) using carriage bolts (41).

(9) Attach braces (49) to support (35) using carriage bolts (33).

(10) Attach assembly of substep (9) to clamp (40) using carriage bolts (41).

(11) Attach braces (47) to supports (35) and (39) and clamp (40) using carriage bolts (37).

(12) Attach support (38) to supports (39), (35) and brace (47) with carriage bolts (30) and (37).

(13) Attach backup block (34) to braces (49) using carriage bolts (32).

(14) Attach assembly of substep (13) to supports (22) using carriage bolts (32).

(15) Mark location of 5/8-inch diameter holes on block (45), see detail E.

(16) Drill 5/8-inch diameter holes through block (45).

(17) Locate notch on block (45), see detail F.

(18) Cut notch on block (45).

WARNING

EC847 is highly flammable. Do not use near open flame or sparks. Use only in well ventilated areas.

(19) Assemble and glue blocks, see view A.

(20) Using block (45) as guide, drill holes through block (21).

(21) Put bushings (46) into 5/8-inch diameter holes drilled in block (45).

WARNING

(22) Glue cushion material (50) to block (45), see view A.

WARNING

(23) Glue cushion material (50) to supports (22), (24), and backup block (34).

b. Install horizontal stabilator into shipping container floor section using sling and substeps below:

(1) Remove actuator arm assembly from horizontal stabilator (A1-F18AC-570-300, WP021 00).

(2) Bag hardware and wrap actuator arm.

(3) Pack hardware and actuator arm in container (27).

(4) Attach brace assembly, view A, to horizontal stabilator using machine bolts (42).

(5) Using sling (A1-F18AC-570-300, WP021 00) position horizontal stabilator in floor section of shipping container so brace assembly is flush on supports (38).

(6) Attach brace assembly, view A, to support (38) using carriage bolts (36).

(7) Remove sling (A1-F18AC-570-300, WP021 00).

c. Attach sides and end to floor section.

(1) Attach sides to skids (11) using lag screws (9).

(2) Attach ends to headers (28) using lag screws (9).

(3) Nail mating surfaces of sides and ends.

(4) Nail top in position.

18. Horizontal Stabilator Removal From Shipping Container.

a. Remove top from shipping container.

b. Remove lag screws (9) from bottom periphery of shipping container.

c. Carefully remove nails from both ends of one side of shipping container and remove side.

d. Remove second side and attached ends as one unit.

e. Attach sling to horizontal stabilator (A1-F18AC-570-300, WP021 00).

f. Remove carriage bolts (36) attaching brace assembly to support (38).

g. Using sling, carefully remove horizontal stabilator from floor sections (23) and (25) of shipping container.

h. Remove brace assembly by removing machine bolts (42) and retain brace assembly and bolts.

19. VERTICAL STABILIZER SHIPPING CONTAINER.

Support Equipment Required

None

Materials Required

See figure 7.

20. **Fabrication of Shipping Container and Installation of Vertical Stabilizer.** Fabricate shipping container and install vertical stabilizer as shown in figure 7 and per procedures below:

a. Fabricate floor section of shipping container per substeps below:

(1) Nail skids (36) to floors (25) and (35).

(2) Attach headers (22) to floors (25) and (35) using carriage bolts (23).

(3) Nail floor supports (24) to floors (25) and (35).

(4) Attach runners (41) to floor (25) and (35) using carriage bolts (26).

(5) Nail rub strips (8) and (11) to skids (36).

b. Attach clamps (31) to gussetts (39) using carriage bolts (30).

c. Attach contour boards (43) to two uprights (42) using carriage bolts (40) and mark no. 31 on contour boards (43).

d. Attach contour boards (46) to remaining two uprights (42) using carriage bolts (40).

e. Nail backup (45) to contour boards (43) and (46).

WARNING

EC847 is highly flammable. Do not use near open flame or sparks. Use only in well ventilated areas.

f. Glue cushion material (44) to backup (45).

g. Attach one gusset (39) to one runner (41), see figure 7.

h. Attach one upright (42), with contour board (43) attached, to gusset (39) using carriage bolts (32).

i. Attach one upright (42), with contour board (46) attached, to same gusset (39) using carriage bolts (32).

j. Locate wedge (33) for installation of carriage bolt (32).

k. Attach gusset (39) to runners (41) using carriage bolts (32).

l. Complete attachment of wedge (33) to gussetts (39) using carriage bolts (32).

WARNING

EC847 is highly flammable. Do not use near open flame or sparks. Use only in well ventilated areas.

m. Glue cushion material (34) to wedge (33).

n. Install support (27) into slot between clamps (31).

WARNING

EC847 is highly flammable. Do not use near open flame or sparks. Use only in well ventilated areas.

o. Glue padding (28) to support (27).

p. Position vertical stabilizer in partly assembled container and manually support vertical stabilizer.

q. Attach upright (42) with contour board (43) attached, to gussett (39). Make sure this upright is opposite upright with contour boards marked 31.

r. Attach remaining upright (42) with contour board (46), attached, to gussett (39). Make sure this upright is opposite with unmarked contour boards.

s. Attach tie support (19) to uprights (42) using carriage bolts (37).

NOTE

Make sure all bolts are tight and there is no movement of vertical stabilizer in container.

t. Assemble sides, ends, and top for shipping container.

u. Attach sides to skids (36) using lag screws (7).

v. Attach ends to headers (22) with lag screws (7).

w. Nail mating surfaces of sides and ends.

x. Nail horizontal joist supports (20) in position.

y. Nail top (1) in position.

21. Vertical Stabilizer Removal from Shipping Container.

a. Remove top (1) from shipping container.

b. Remove horizontal joist supports (20).

c. Remove lag screws (7) from bottom periphery of shipping container.

d. Remove nails from both ends of one side and remove side.

e. Remove second side and attached ends as one unit.

f. Remove tie supports (19) by removing carriage bolts (37).

g. Remove carriage bolt (32) from gussetts (39) and wedge (33).

h. Remove carriage bolts (26) holding runner assemblies (41) while manually holding vertical stabilizer in place.

i. Vertical stabilizer is now free to remove from shipping container.

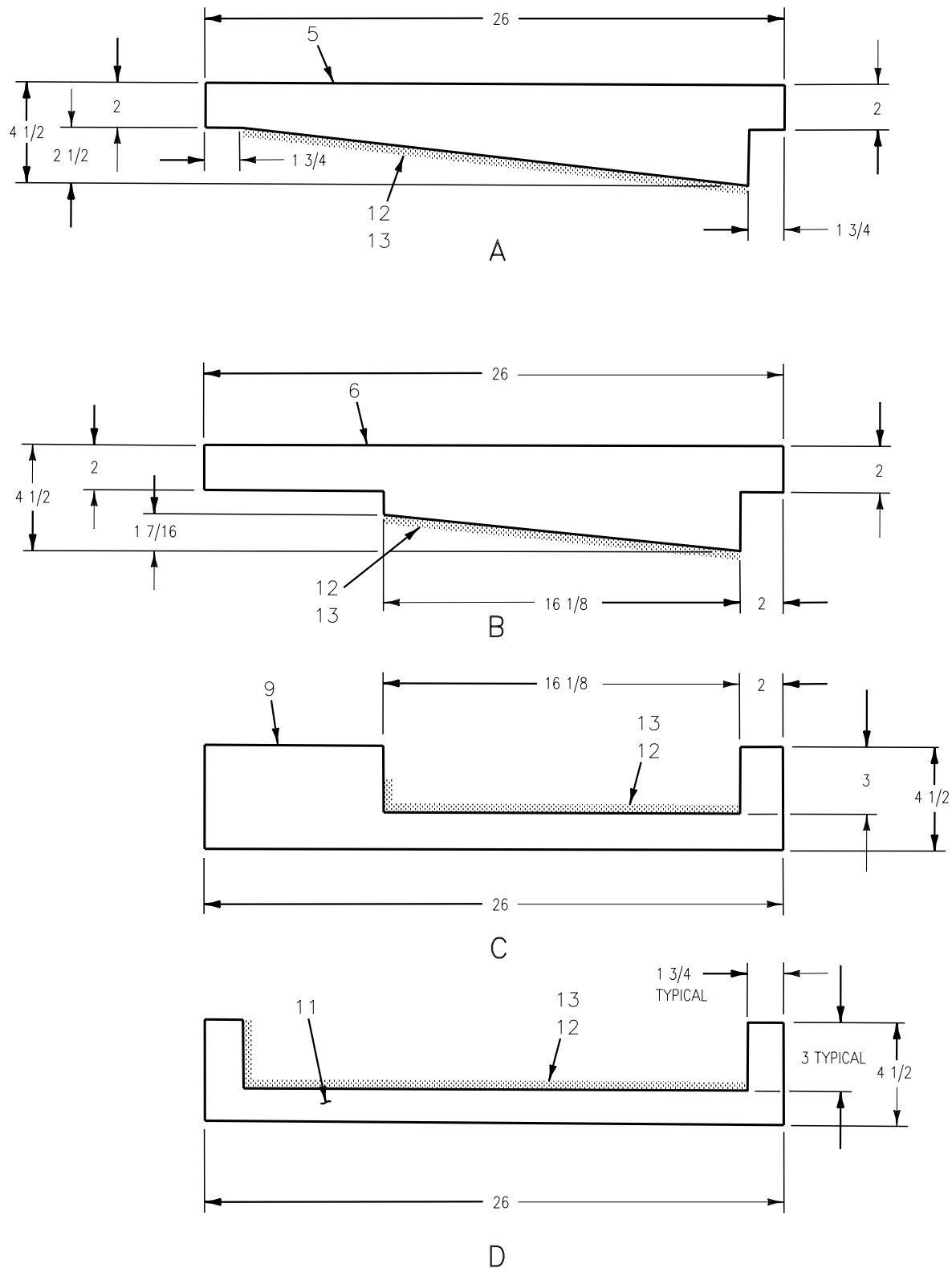


Figure 1. Rudder Shipping Container (Sheet 2)

BILL OF MATERIALS				
ITEM	QTY	NOMENCLATURE	SIZE	REMARKS
1	4	CLEAT	1 X 2 X 23	
2	4	CLEAT	1 X 2 X 6 1/2	
3	1	TOP, SHEATHING	1/4 X 28 X 70	
4	2	SIDE, SHEATHING	1 X 6 1/2 X 70	
5	1	CONTOUR	1/4 X 6 1/2 X 26	
6	1	CONTOUR	2 X 4 1/2 X 26	
7	2	END, SHEATHING	2 X 4 1/2 X 26	
8	8	SUPPORT	1 X 2 X 6 1/2	
9	1	CONTOUR BOARD	2 X 4 1/2 X 26	
10	1	FLOOR, SHEATHING	1 X 28 X 70	
11	1	CONTOUR BOARD	2 X 4 1/2 X 26	
12	A/R	CUSHION MATERIAL	AS REQUIRED	2
13	A/R	EC-847 ADHESIVE	AS REQUIRED	2

LEGEND

1. RUDDER WEIGHT IS 17 POUNDS AND GROSS WEIGHT OF SHIPPING CONTAINER AND RUDDER IS APPROXIMATELY 52 POUNDS.

2 CUSHION MATERIAL, POLYETHYLENE, PPP-C-1752, GLUED INTO POSITION WITH EC-847 ADHESIVE.

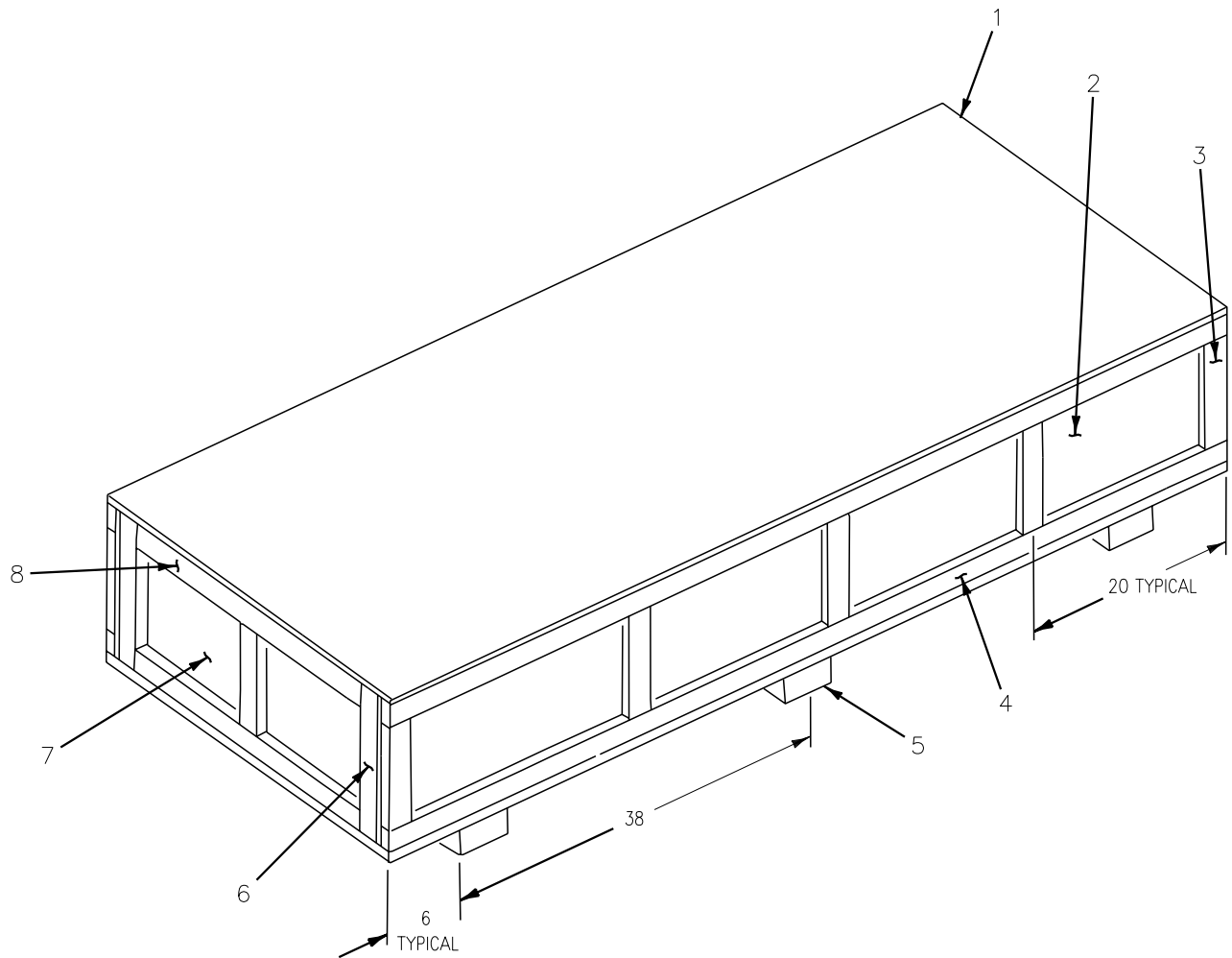


Figure 2. Speed Brake Shipping Container (Sheet 1)

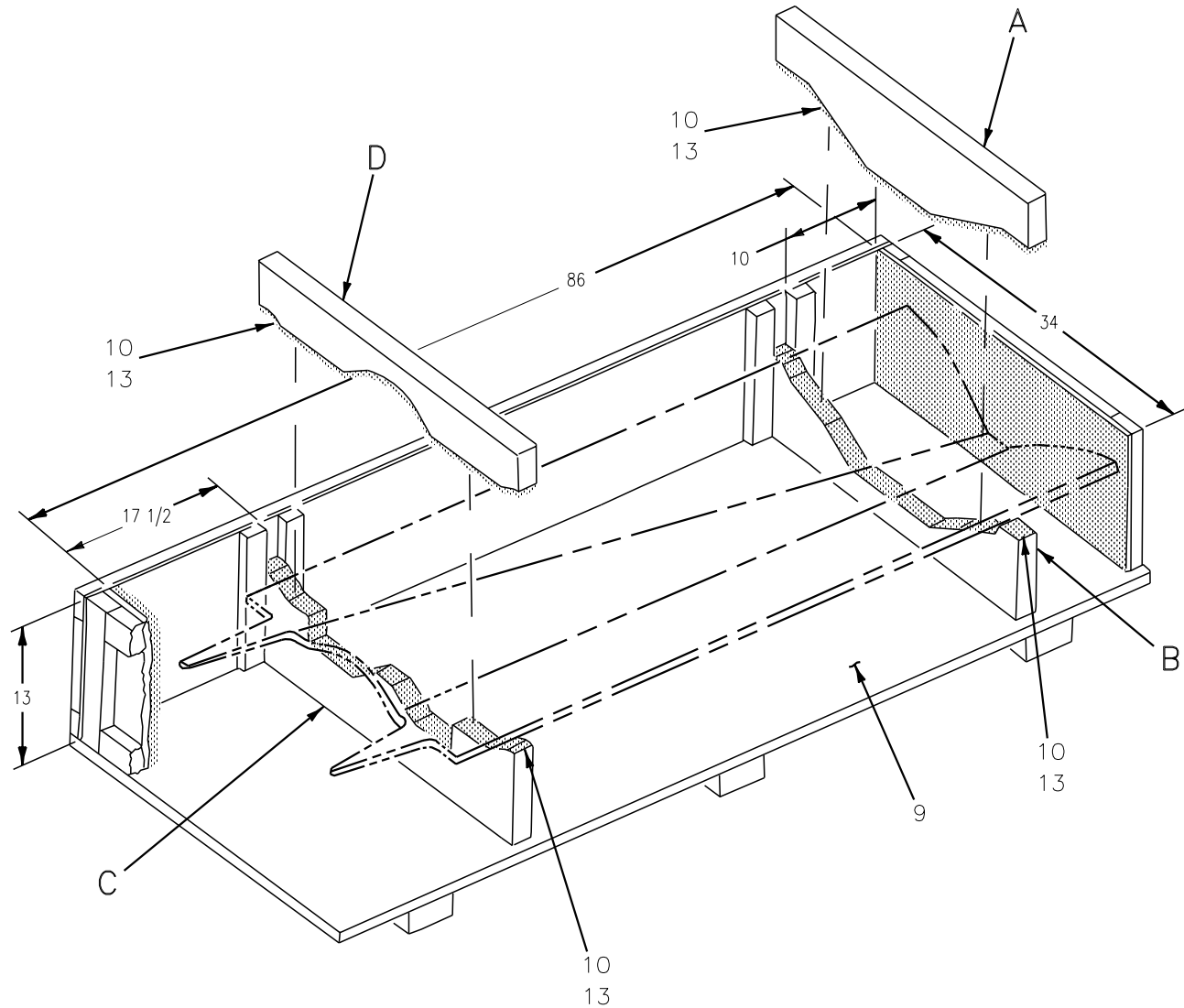
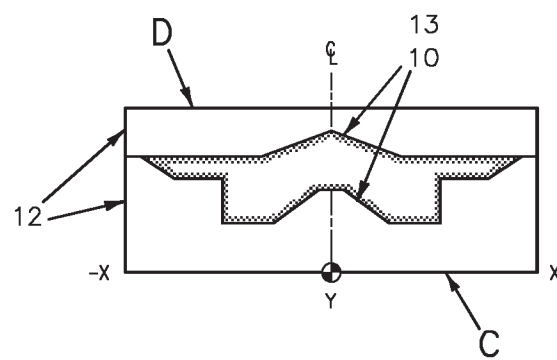
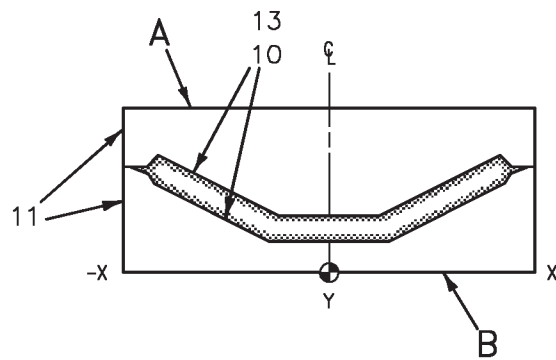


Figure 2. Speed Brake Shipping Container (Sheet 2)



18AC-SRM-20-(116-3)31-SCAN

A		B	
±X	Y	±X	Y
0	4 1/2	0	2 1/2
4	4 1/2	5	2 1/2
9	7	9	5
14	9	14	7
16	8 1/2	14 1/2	8
17	8 1/2	15	8
		16	8 1/2
		17	8 1/2

D		C	
±X	Y	±X	Y
0	11	0	7
2 1/2	10 1/2	1	7
6	8 3/4	4	5
15	8 3/4	9	5
16	9	9	7 1/2
17	9	13	7 1/2
		14 1/2	8
		15	8 1/2
		16	9
		17	9

BILL OF MATERIALS				
ITEM	QTY	NOMENCLATURE	SIZE	REMARKS
1	1	TOP, SHEATHING	3/8 X 36 X 88	
2	2	SIDE, SHEATHING	1/4 X 13 X 88	
3	12	CLEAT	1 X 2 X 10	
4	4	CLEAT	1 X 2 X 88	
5	3	RUB STRIP	2 X 4 X 36	
6	12	CLEAT	1 X 2 X 13	
7	2	END, SHEATHING	1/4 X 13 X 34	
8	4	CLEAT	1 X 2 X 31	
9	1	FLOOR, SHEATHING	1 X 36 X 88	
10	A/R	CUSHION, MATERIAL	AS REQUIRED	2
11	1	CONTOUR BOARD	2 X 13 X 34	
12	1	CONTOUR BOARD	2 X 13 X 34	
13	A/R	EC-847 ADHESIVE	AS REQUIRED	2

LEGEND

1. SPEED BRAKE WEIGHT IS 57 POUNDS AND GROSS WEIGHT IS SHIPPING CONTAINER AND SPEED BRAKE IS APPROXIMATELY 100 POUNDS.

2 CUSHION MATERIAL POLYETHYLENE, PPP-C-1752, GLUED INTO POSITION WITH EC-847 ADHESIVE.

Figure 2. Speed Brake Shipping Container (Sheet 3)

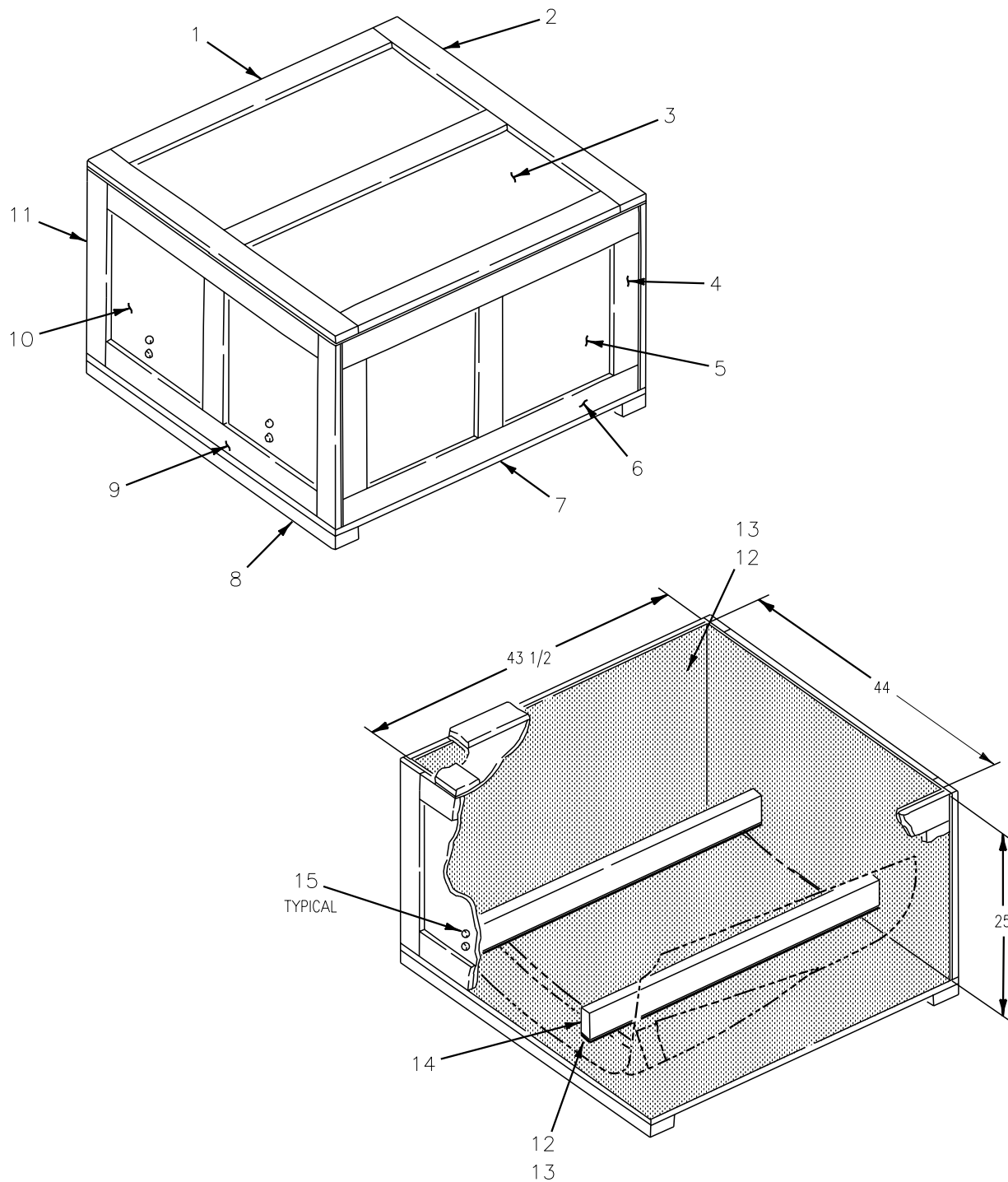


Figure 3. Forward Engine Bay Door Shipping Container (Sheet 1)

BILL OF MATERIALS				
ITEM	QTY	NOMENCLATURE	SIZE	REMARKS
1	2	CLEAT	1 X 4 X 38 1/2	
2	2	CLEAT	1 X 4 X 46	
3	1	TOP, SHEATHING	1/4 X 45 1/2 X 46	
4	8	CLEAT	1 X 4 X 18	
5	2	SIDE, SHEATHING	1/4 X 25 X 43 1/2	
6	4	CLEAT	1 X 4 X 43 1/2	
7	1	FLOOR	1 X 45 1/2 X 46	
8	2	RUB STRIP	2 X 4 X 46	
9	4	CLEAT	1 X 4 X 39	
10	2	END, SHEATHING	1/4 X 25 X 46	
11	2	CLEAT	1 X 4 X 25	
12	A/R	CUSHION MATERIAL	AS REQUIRED	3
13	A/R	EC-847 ADHESIVE	AS REQUIRED	3
14	2	CONTOUR BOARD	2 X 4 X 43 1/2	
15	8	LAG SCREW	3/8 X 2	2

LEGEND

1. FORWARD ENGINE ACCESS DOOR WEIGHT IS 39 POUNDS AND GROSS WEIGHT OF SHIPPING CONTAINER AND FORWARD ENGINE ACCESS DOOR IS APPROXIMATELY 65 POUNDS.

2 USE 3/16-INCH TWIST DRILL TO MAKE PILOT HOLES.

3 CUSHION MATERIAL, POLYETHYLENE, PPP-C-1752, GLUED INTO POSITION WITH EC-847 ADHESIVE.

Figure 3. Forward Engine Bay Doors Shipping Container (Sheet 2)

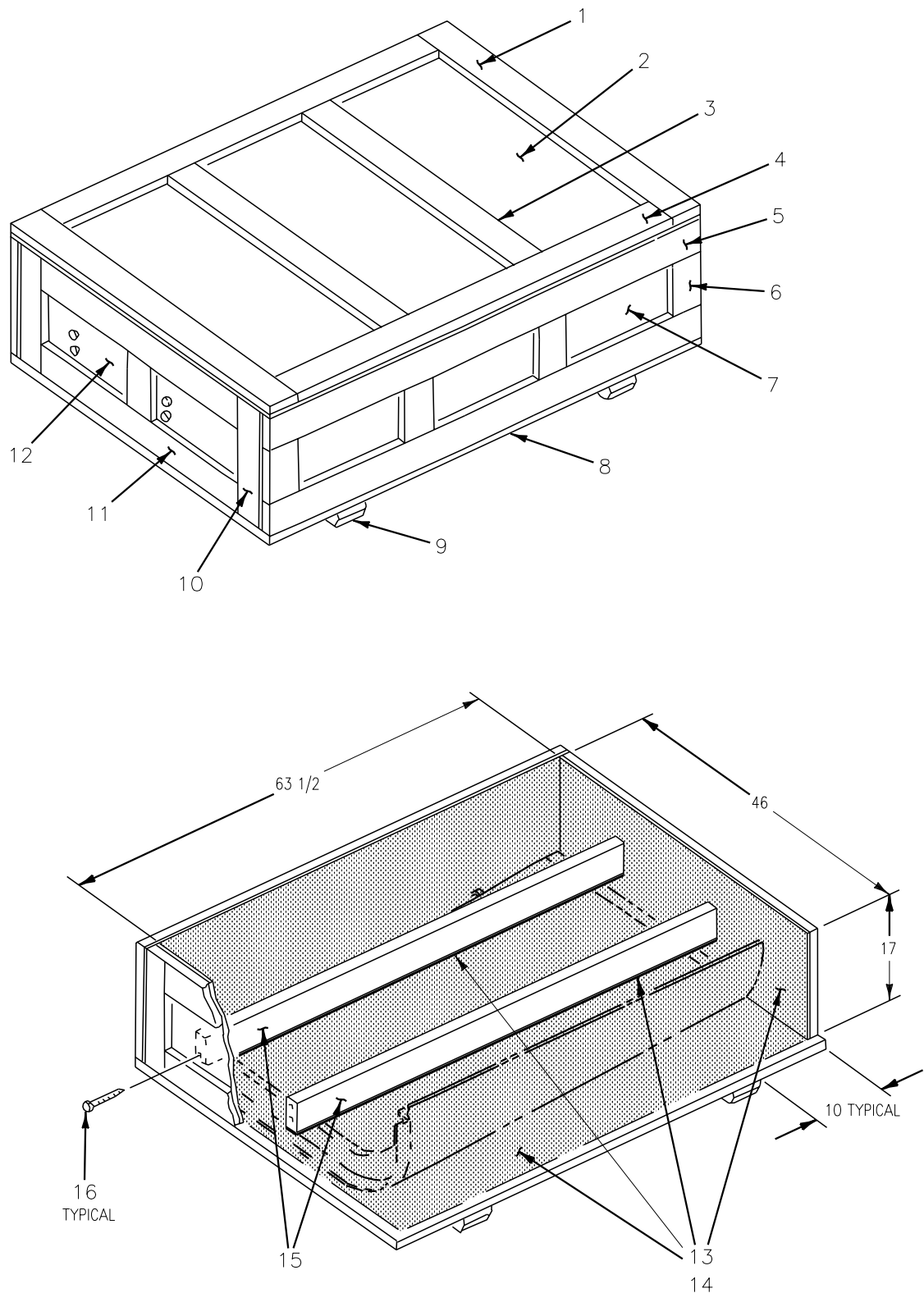


Figure 4. Center Engine Bay Door Shipping Container (Sheet 1)

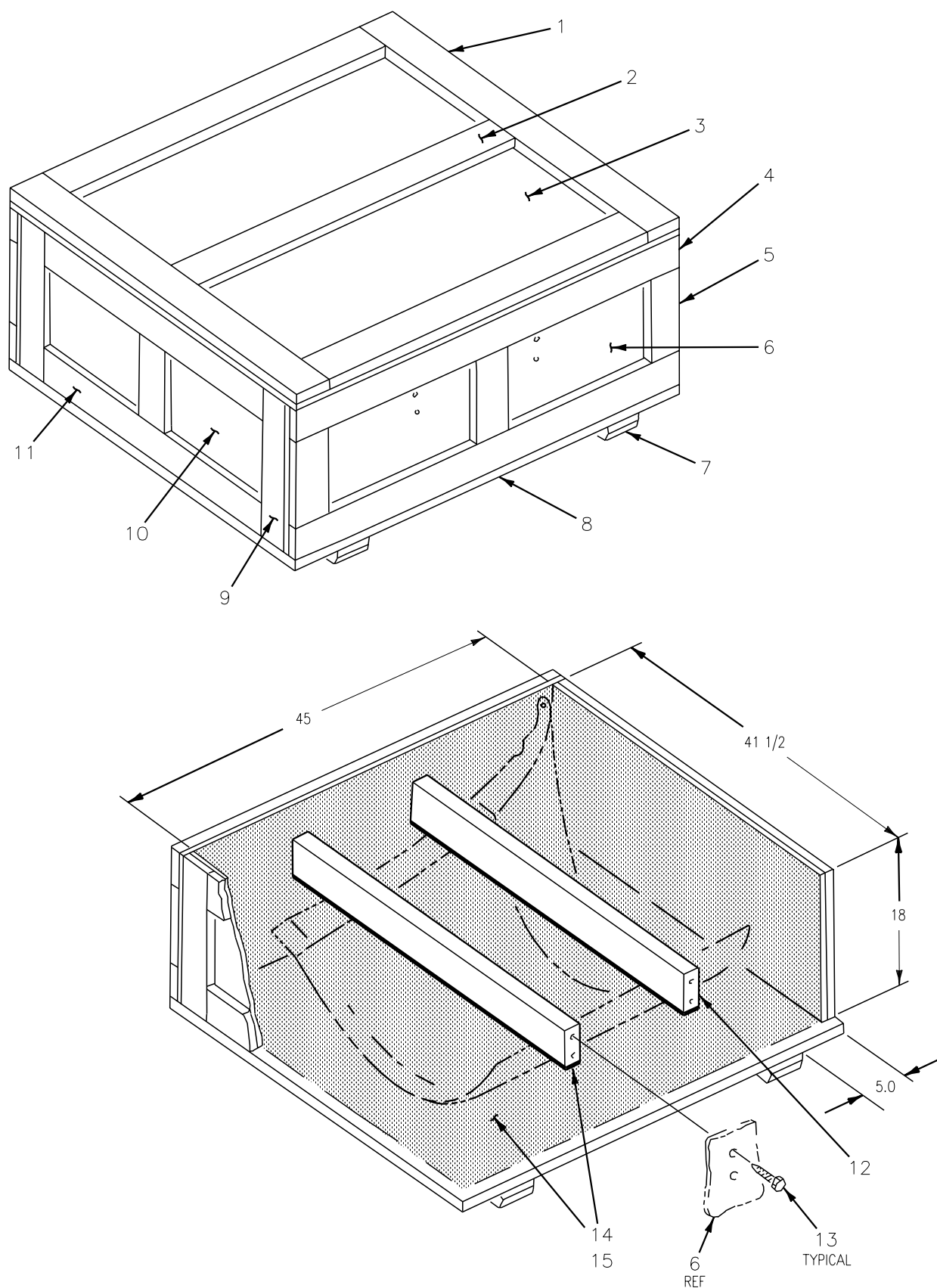
BILL OF MATERIALS				
ITEM	QTY	NOMENCLATURE	SIZE	REMARKS
1	2	CLEAT	1 X 4 X 48	
2	1	TOP, SHEATHING	1/4 X 48 X 64 1/2	
3	2	CLEAT	1 X 4 X 41	
4	2	CLEAT	1 X 4 X 57 1/2	
5	4	CLEAT	1 X 4 X 64 1/2	
6	10	CLEAT	1 X 4 X 10	
7	2	SIDE, SHEATHING	1/4 X 17 X 64 1/2	
8	1	FLOOR, SHEATHING	1 X 48 X 64 1/2	
9	4	RUB STRIP	2 X 4 X 48	
10	4	CLEAT	1 X 4 X 17	
11	4	CLEAT	1 X 4 X 39	
12	2	END, SHEATHING	1/4 X 17 X 46	
13	A/R	CUSHION MATERIAL	AS REQUIRED	◀ 3
14	2	EC-847 ADHESIVE	AS REQUIRED	◀ 3
15	2	CONTOUR BOARD	2 X 4 X 62 1/2	
16	8	LAG SCREW	3/8 X 2	◀ 2

LEGEND

1. CENTER ENGINE ACCESS DOOR WEIGHT IS 64 POUNDS AND GROSS WEIGHT OF SHIPPING CONTAINER AND CENTER ENGINE ACCESS DOOR IS APPROXIMATELY 180 POUNDS.

2 ▶ USE 3/16-INCH TWIST DRILL TO MAKE PILOT HOLES.

3 ▶ CUSHION MATERIAL, POLYETHYLENE, PPP-C-1752, GLUED INTO POSITION WITH EC-847 ADHESIVE.



18AC-SRM-20-(119-1)39-CATI

Figure 5. Aft Engine Bay Door Shipping Container (Sheet 1)

BILL OF MATERIALS				
ITEM	QTY	NOMENCLATURE	SIZE	REMARKS
1	2	CLEAT	1 X 4 X 43 1/2	
2	3	CLEAT	1 X 4 X 38	
3	1	TOP, SHEATHING	1/4 X 43 1/2 X 47	
4	4	CLEAT	1 X 4 X 47	
5	8	CLEAT	1 X 4 X 11	
6	2	SIDE, SHEATHING	1/4 X 18 X 47	
7	4	RUB STRIP	2 X 4 X 43 1/2	
8	1	FLOOR, SHEATHING	1 X 43 1/2 X 47	
9	4	CLEAT	1 X 4 X 18	
10	2	END, SHEATHING	1/4 X 18 X 41 1/2	
11	4	CLEAT	1 X 4 X 34 1/2	
12	2	CONTOUR BOARDS	2 X 4 X 41 1/2	
13	8	LAG SCREW	3/8 X 2	2
14	A/R	CUSHION MATERIAL	AS REQUIRED	3
15	A/R	EC-847 ADHESIVE	AS REQUIRED	3

LEGEND

1. AFT ENGINE ACCESS DOOR WEIGHT IS 24 POUNDS AND GROSS WEIGHT OF SHIPPING CONTAINER AND AFT ENGINE ACCESS DOOR IS APPROXIMATELY 65 POUNDS.

2 USE 3/16-INCH TWIST DRILL TO MAKE PILOT HOLES.

3 CUSHION MATERIAL, POLYETHYLENE, PPP-C-1752, GLUED INTO POSITION WITH EC-847 ADHESIVE.

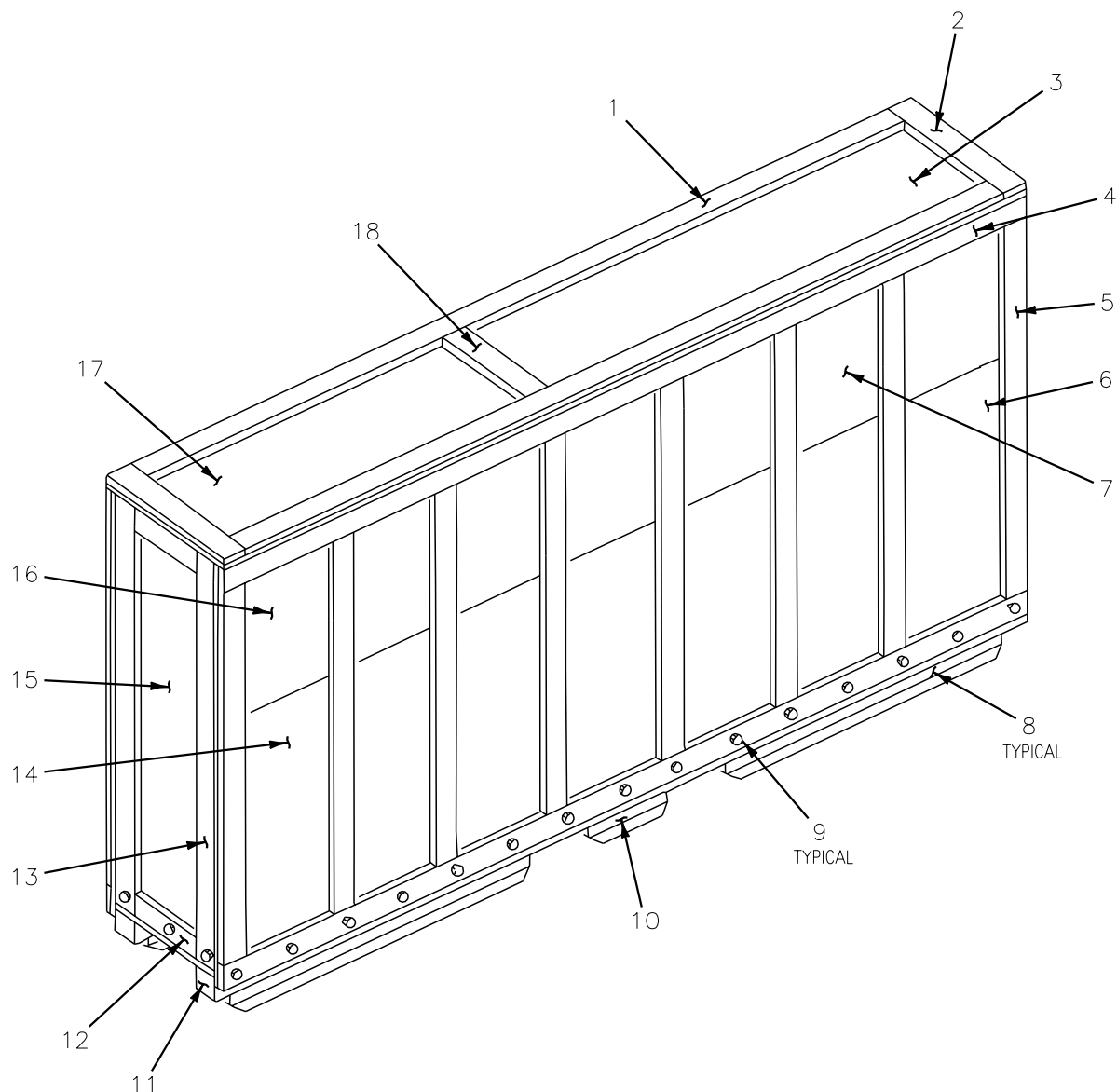


Figure 6. Horizontal Stabilator Shipping Container (Sheet 1)

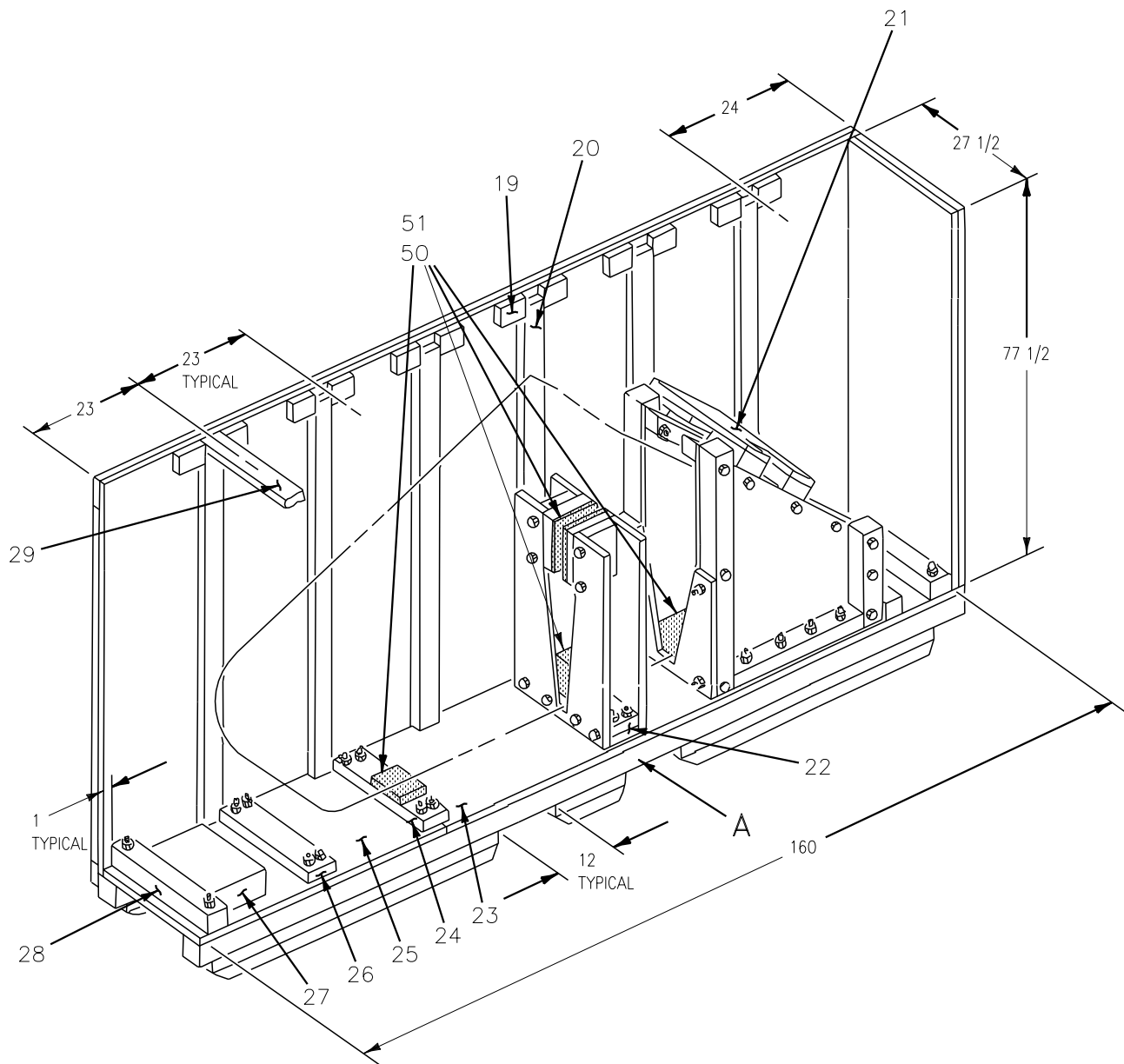


Figure 6. Horizontal Stabilator Shipping Container (Sheet 2)

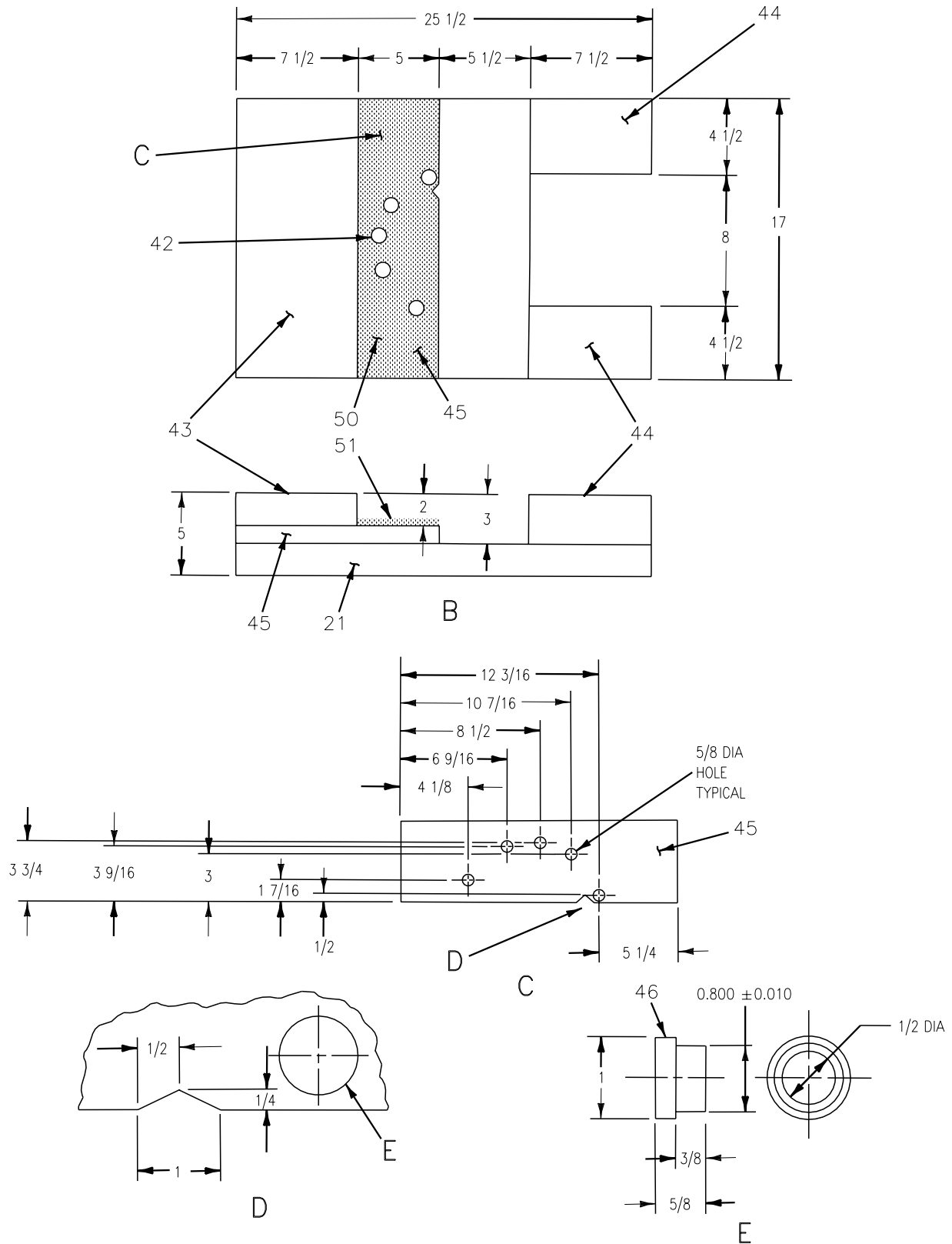


Figure 6. Horizontal Stabilizer Shipping Container (Sheet 4)

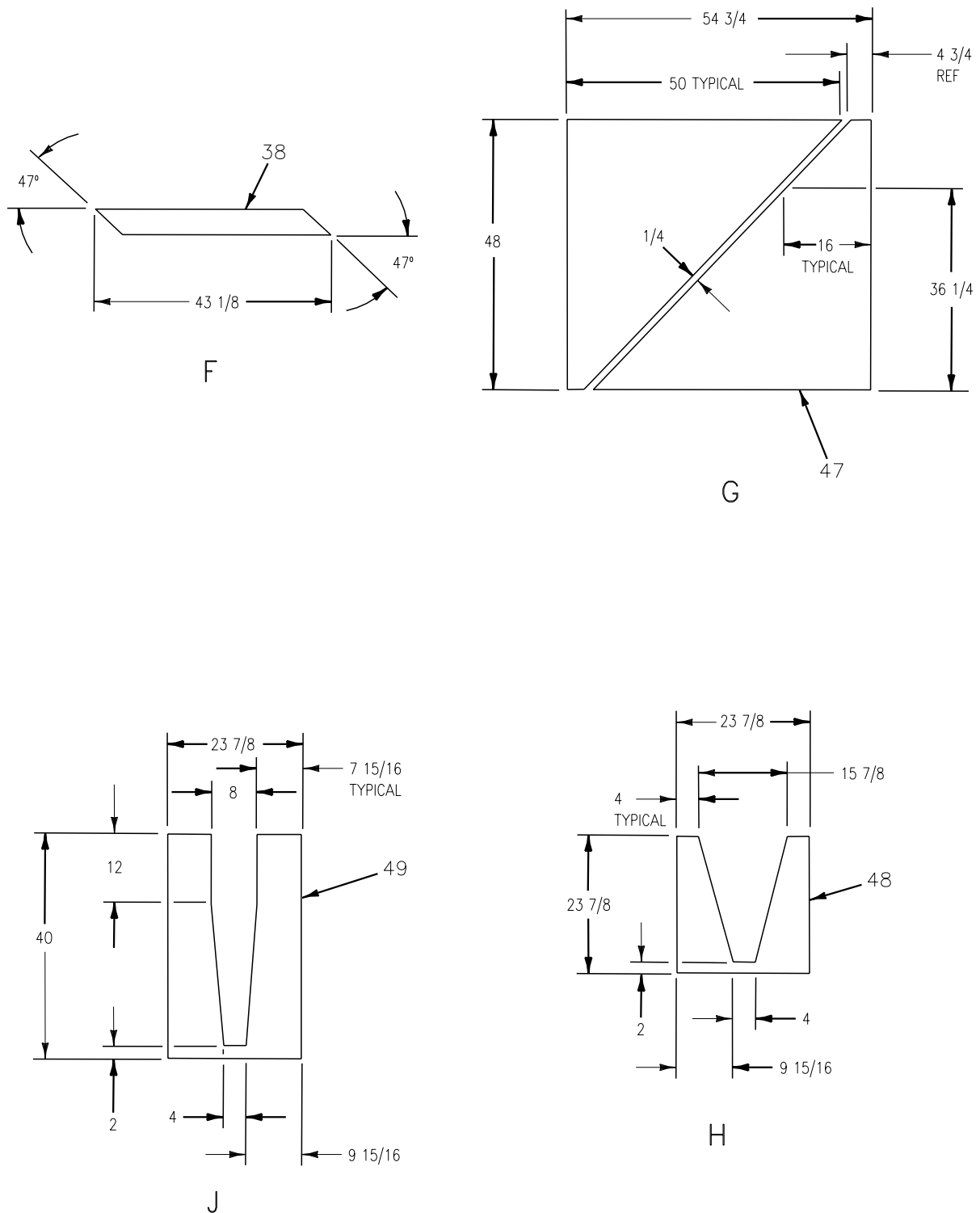


Figure 6. Horizontal Stabilizer Shipping Container (Sheet 5)

BILL OF MATERIALS				
ITEM	QTY	NOMENCLATURE	SIZE	REMARKS
1	2	CLEAT	1 X 4 X 155	<div>2</div>
2	2	CLEAT	1 X 4 X 29 1/2	
3	1	TOP, SHEATHING	1/4 X 29 1/2 X 96	
4	4	CLEAT	1 X 4 X 162	
5	16	CLEAT	1 X 4 X 72 1/2	
6	2	SIDE, SHEATHING	1/4 X 48 X 96	
7	2	SIDE, SHEATHING	1/4 X 31 1/2 X 96	
8	8	RUB STRIP	2 X 4 X 58	
9	36	LAG SCREW	1/2 X 2 1/2	
10	4	RUB STRIP	2 X 4 X 16	
11	2	SKID	4 X 4 X 162	
12	4	CLEAT	1 X 4 X 20 1/2	
13	4	CLEAT	1 X 4 X 77 1/2	
14	2	SIDE, SHEATHING	1/4 X 48 X 66	
15	2	END, SHEATHING	1/4 X 27 1/2 X 77 1/2	
16	2	SIDE, SHEATHING	1/4 X 31 1/2 X 66	
17	1	TOP, SHEATHING	1/4 X 29 1/2 X 66	
18	1	CLEAT	1 X 4 X 22 1/2	
19	24	SUPPORT	1 X 4 X 5	
20	12	JOIST	1 X 4 X 77 1/2	
21	1	BLOCK	2 X 17 X 25 1/2	
22	2	SUPPORT	2 X 6 X 26	
23	1	FLOOR, SHEATHING	1 X 27 1/2 X 96	
24	1	SUPPORT	2 X 6 X 26	
25	1	FLOOR, SHEATHING	1 X 27 1/2 X 66	
26	1	SUPPORT	2 X 6 X 26 1/2	
27	1	CONTAINER	5 X 12 X 15	
28	3	HEADER	4 X 4 X 27 1/2	
29	6	JOIST	1 X 4 X 27 1/2	
30	26	CARRIAGE BOLT WITH HWR	1/2 X 9	
31	8	CARRIAGE BOLT WITH HWR	1/2 X 7	
32	8	CARRIAGE BOLT WITH HWR	1/2 X 8	
33	4	CARRIAGE BOLT WITH HWR	1/2 X 6	

Figure 6. Horizontal Stabilator Shipping Container (Sheet 6)

BILL OF MATERIALS				
ITEM	QTY	NOMENCLATURE	SIZE	REMARKS
34	2	BACKUP BLOCK	2 X 6 X 7	
35	2	SUPPORT	4 X 4 X 50	
36	4	CARRIAGE BOLT WITH HWR	1/2 X 10	
37	10	CARRIAGE BOLT WITH HWR	1/2 X 5	
38	2	SUPPORT	4 X 4 X 43 1/8	
39	2	SUPPORT	4 X 4 X 19 1/4	
40	2	CLAMP	4 X 4 X 36 1/4	
41	4	CARRIAGE BOLT WITH HWR	1/2 X 5	
42	5	MACHINE BOLT WITH HWR	1/2 X 5	
43	1	BLOCK	2 X 7 1/2 X 17	
44	2	BLOCK	3 X 4 1/2 X 7 1/2	
45	1	BLOCK	1 X 12 1/2 X 17	
46	5	BUSHING	1 X 5/8	
47	2	BRACE	3/4 X 48 X 54 3/4	
48	2	SUPPORT	3/4 X 23 7/8 X 23 7/8	
49	2	BRACE	3/4 X 23 7/8 X 40	
50	A/R	CUSHION MATERIAL	AS REQUIRED	3
51	A/R	EC-847 ADHESIVE	AS REQUIRED	3

LEGEND

1. HORIZONTAL STABILATOR WEIGHT IS 155 POUNDS AND GROSS WEIGHT OF SHIPPING CONTAINER AND HORIZONTAL STABILATOR IS APPROXIMATELY 345 POUNDS.

2 USE 3/8-INCH TWIST DRILL TO MAKE PILOT HOLES.

3 CUSHION MATERIAL, POLYETHYLENE, PPP-C-1752, GLUED INTO POSITION WITH EC-847 ADHESIVE.

4 NOTCH TO CENTER OF EACH PIECE.

Figure 6. Horizontal Stabilator Shipping Container (Sheet 7)

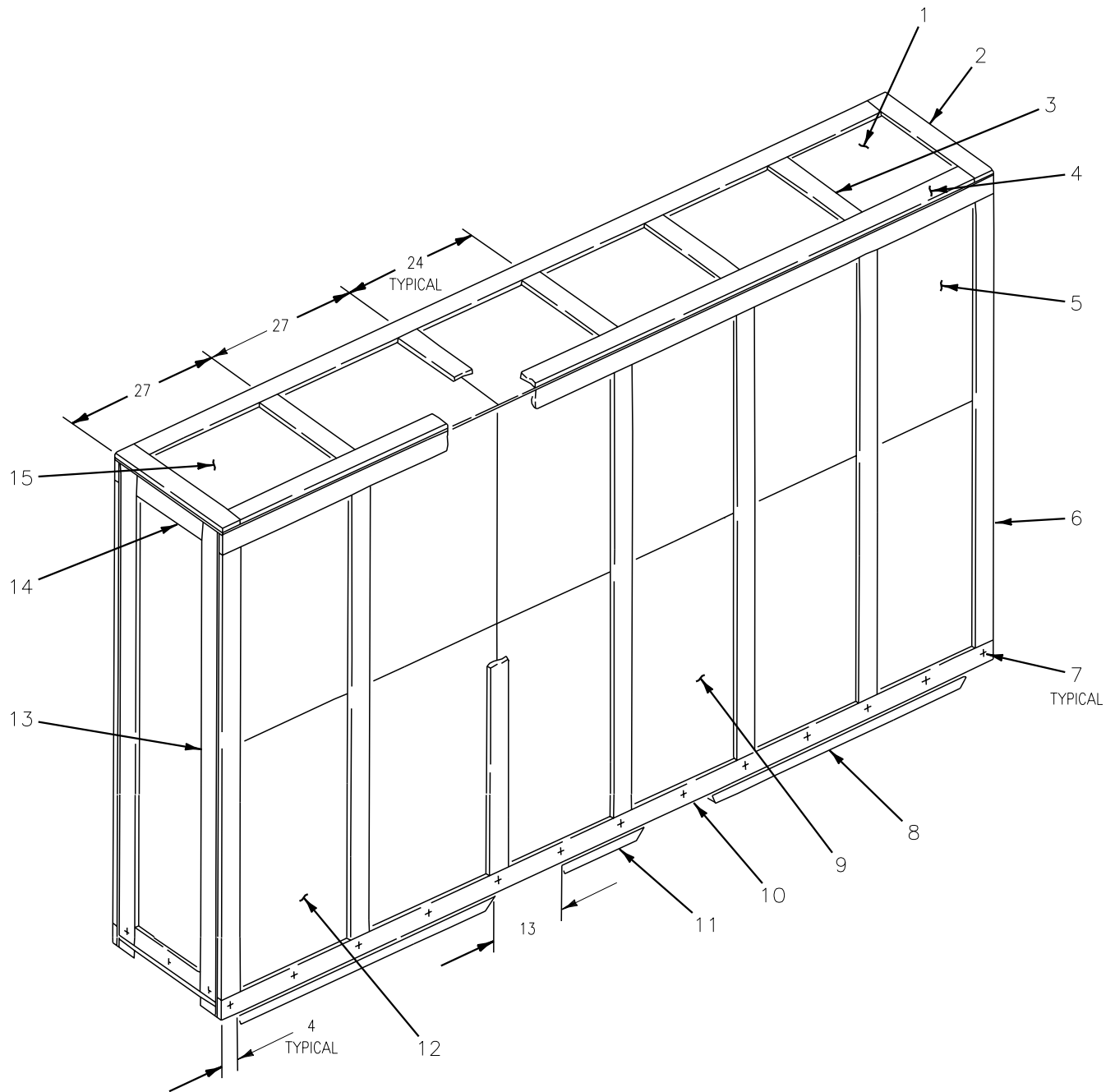


Figure 7. Vertical Stabilizer Shipping Container (Sheet 1)

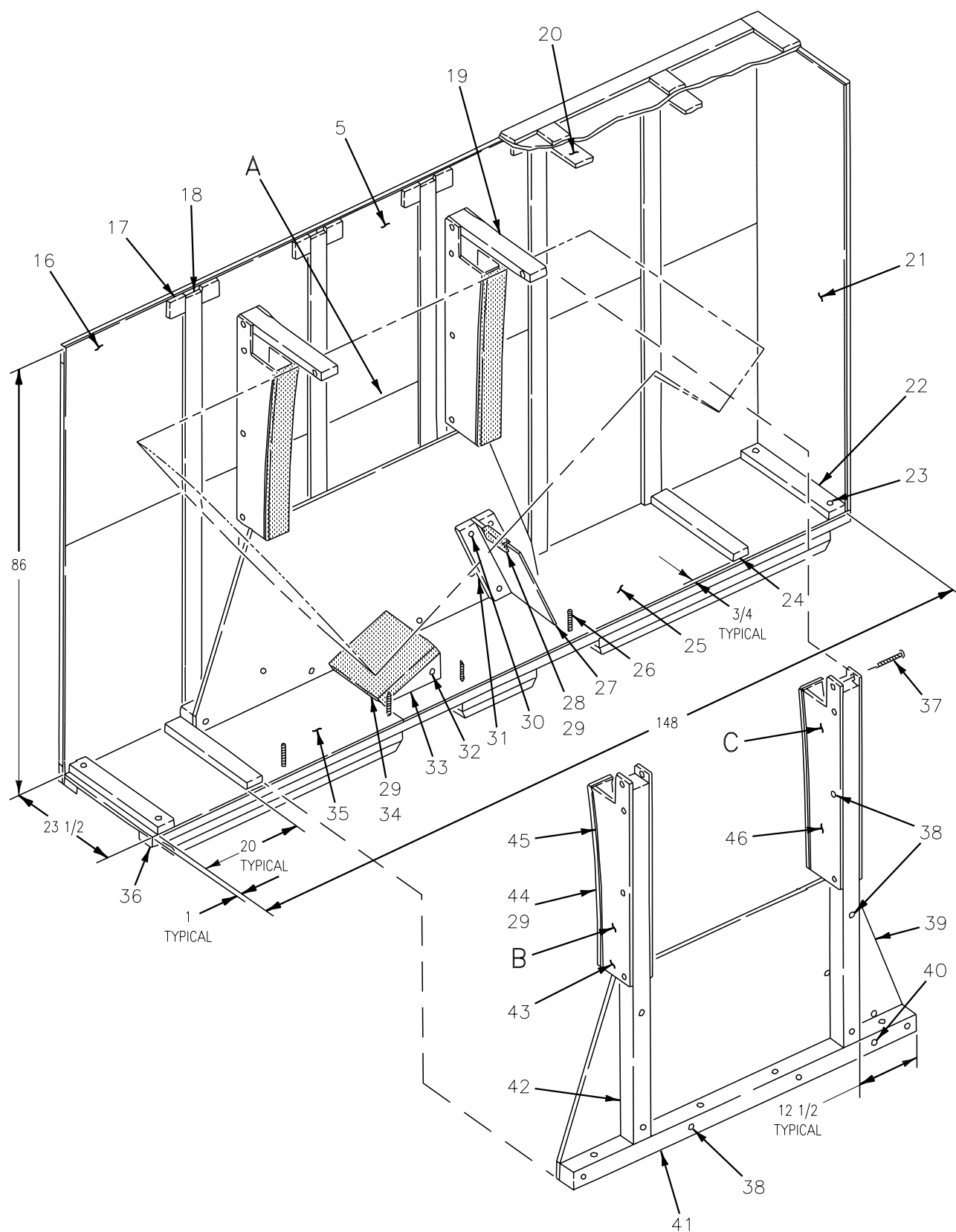
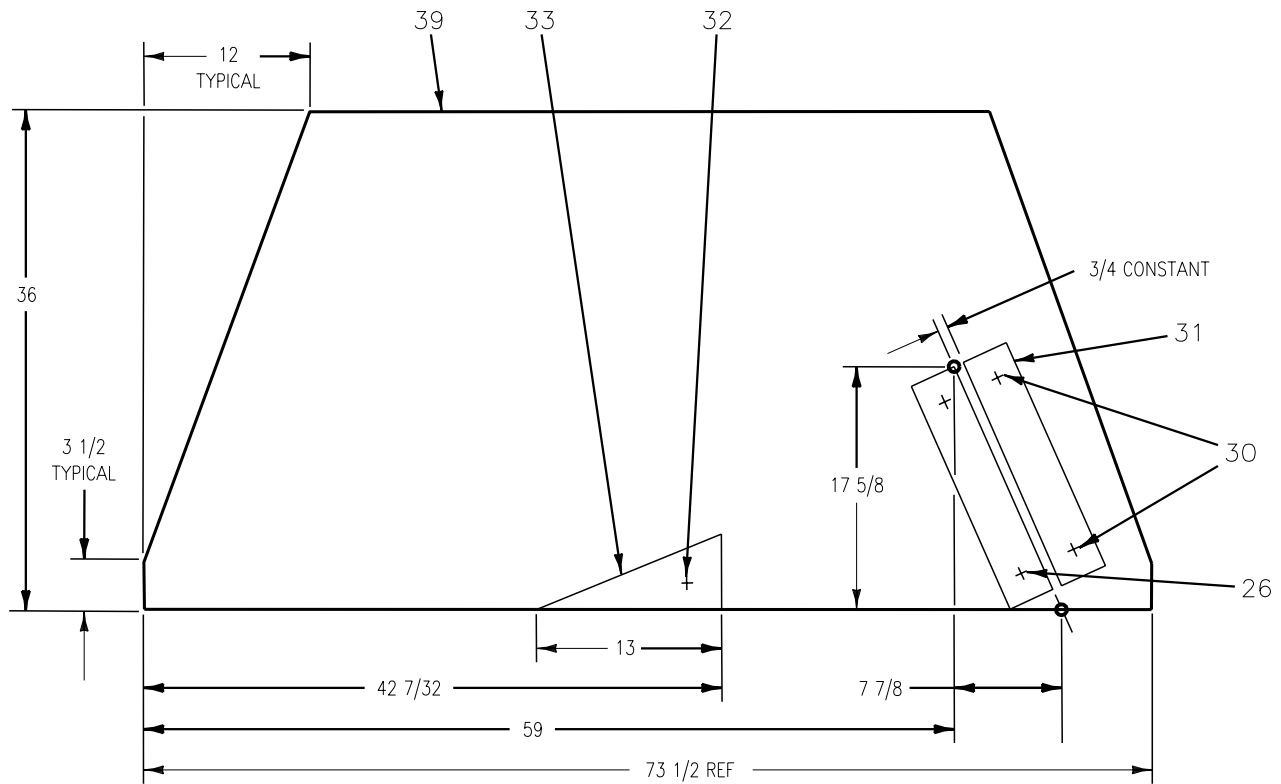
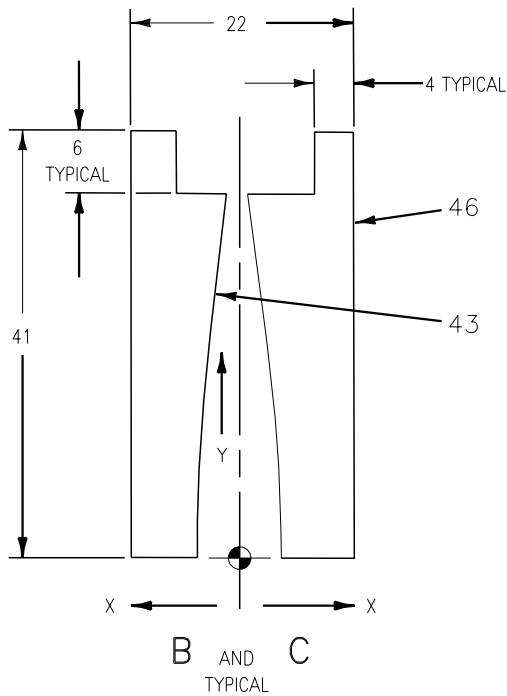


Figure 7. Vertical Stabilizer Shipping Container (Sheet 2)



A
TYPICAL



43	
X	Y
3 7/8	0
3 7/8	2
3 13/16	4
3 3/4	6
3 11/16	8
3 5/8	10
3 9/16	12
3 7/16	14
3 3/8	16
3 1/4	18
3 1/16	20
2 15/16	22
2 3/4	24
2 1/2	26
2 5/16	28
2 1/16	30
1 3/4	32
1 1/2	34
1 5/16	35

46	
X	Y
2 3/16	0
2 3/4	2
2 11/16	4
2 5/8	6
2 9/16	8
2 1/2	10
2 3/8	12
2 5/16	14
2 3/16	16
2 1/8	18
2 1/32	20
1 15/16	22
1 7/8	24
1 3/4	26
1 11/16	28
1 9/16	30
1 1/2	32
1 3/8	34
1 5/16	35

Figure 7. Vertical Stabilizer Shipping Container (Sheet 3)

BILL OF MATERIALS				
ITEM	QTY	NOMENCLATURE	SIZE	REMARKS
1	1	TOP, SHEATHING	1/4 X 25 X 1/2 X 96	
2	2	CLEAT	1 X 4 X 25 1/2	
3	5	CLEAT	1 X 4 X 18 1/2	
4	2	CLEAT	1 X 4 X 143	
5	2	SIDE, SHEATHING	1/4 X 40 X 96	
6	14	CLEAT	1 X 4 X 88	
7	32	LAG SCREW	3/8 X 2	2
8	8	RUB STRIP	2 X 4 X 50	
9	2	SIDE, SHEATHING	1/4 X 48 X 96	
10	4	CLEAT	1 X 4 X 150	
11	4	RUB STRIP	2 X 4 X 16	
12	2	SIDE, SHEATHING	1/4 X 48 X 54	
13	4	CLEAT	1 X 4 X 86	
14	4	CLEAT	1 X 4 X 16 1/2	
15	1	TOP, SHEATHING	1/2 X 25 1/2 X 54	
16	2	SIDE, SHEATHING	1/4 X 40 X 54	
17	20	JOIST SUPPORT	1 X 4 X 4	
18	10	JOIST	1 X 4 X 85 1/4	
19	2	TIE SUPPORT	2 X 4 X 22	
20	5	HORIZONTAL JOIST SUPPORT	1 X 4 X 23 1/2	
21	2	END, SHEATHING	1/4 X 23 1/2 X 86	
22	2	HEADER	2 X 4 X 23 1/2	
23	4	CARRIAGE BOLT AND HARDWARE	3/8 X 4	
24	2	FLOOR SUPPORT	2 X 4 X 22	
25	1	FLOOR SHEATHING	1/2 X 23 1/2 X 96	
26	8	CARRIAGE BOLT AND HARDWARE	1/2 X 6 1/2	
27	1	SUPPORT	1 X 13 X 18 1/2	
28	1	RUBBER PADDING	1/4 X 6 X 6	3
29	A/R	EC-847 ADHESIVE	AS REQUIRED	4
30	6	CARRIAGE BOLT AND HARDWARE	3/8 X 3	
31	4	CLAMP	2 X 4 X 17 3/4	
32	1	CARRIAGE BOLT AND HARDWARE	3/8 X 16	
33	1	WEDGE	13 X 13 X 5 1/2	
34	1	CUSHION MATERIAL	2 X 13 X 13	4
35	1	FLOOR SHEATHING	1/2 X 23 1/2 X 54	
36	2	SKID	2 X 4 X 150	
37	4	CARRIAGE BOLT AND HARDWARE	1/8 X 5	
38	30	CARRIAGE BOLT AND HARDWARE	3/8 X 5	
39	2	GUSSET, SHEATHING	1 X 36 X 73 1/2	
40	2	CARRIAGE BOLT AND HARDWARE	3/8 X 7	
41	2	RUNNER	4 X 4 X 73 1/2	
42	4	UPRIGHT	4 X 4 X 72	
43	4	CONTOUR BOARD, SHEATHING	1/2 X 22 X 41	
44	4	CUSHION MATERIAL	1 X 4 1/2 X 35	4
45	4	BACKUP SHEATHING	1/4 X 4 1/2 X 35	
46	4	CONTOUR BOARD, SHEATHING	1/2 X 22 X 41	

LEGEND

1. VERTICAL STABILIZER WEIGHT IS 201 POUNDS AND GROSS WEIGHT OF SHIPPING CONTAINER AND VERTICAL STABILIZER IS APPROXIMATELY 450 POUNDS.

2. USE 1/4-INCH TWIST DRILL TO MAKE PILOT HOLES.
3. RUBBER PADDING, MIL-R-6855, GLUED INTO POSITION WITH EC-847 ADHESIVE.
4. CUSHION MATERIAL, POLYETHYLENE, PPP-C-1752, GLUED INTO POSITION WITH EC-847 ADHESIVE.

Figure 7. Vertical Stabilizer Shipping Container (Sheet 4)

INTERMEDIATE AND DEPOT MAINTENANCE

STRUCTURE REPAIR

INTERNATIONAL ANNEALED COPPER STANDARD

Reference Materials

None

Alphabetical Index

Subject

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International Annealed Copper Standard	1
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Record of Applicable Technical Directives

None

1. INTERNATIONAL ANNEALED COPPER STANDARD.

determine temper of material or temper of material after heat treatment. Percent IACS and rockwell hardness reading are contained in table 1 below:

2. International annealed copper standard (IACS) data contained in this work package is used to

Table 1. Percent IACS and Rockwell Hardness Readings (Aluminum)



















Product Form	Alloy Temper 	Percent IACS	Rockwell Hardness
Clad Sheet	2024-T72 2024-T81 7075-T6X 7075-T76	39-45 37-41 30.5-36 36-40	B56-76 B64-min. B76-90 B74-88
Bare Sheet	2024-T72 2024-T81 6061-T4X 6061-T6X 7075-T6X 7075-T76	38-45 36-41 41.1-42.5  35-41 40-45 30.5-34.5 36-40	B64-76 B74.5 min. B74.5 min. E60 min. B47-72 B87 min. B82-88

Table 1. Percent IACS and Rockwell Hardness Readings (Aluminum) (Continued)

Product Form	Alloy Temper 	Percent IACS	Rockwell Hardness
Plate	2024/2124-T851 7050-T736X 7075-T73, T735X	36-41 41.1-42.5  38-39.9 40-41-.5  38-41 41.1-43 	B74.5 min. B74.5 min. B82-88 B82 min. B78-84 B78 min.
Hand and Die Forgings	2219-T6 2219-T85X 6061-T6, T65X 7049/7149-T73 or -T735X 7050-T736, T7365X 7075-T73, T735X 7075/7175-T736 7075/7175-T3652	28-35 28-35 40-45 38-41 41.1-43  38-39.9 40-41.5  38-41 41.1-43  38-41.5 41.6-43  38-41.5  41.6-43 	B72-80 B75 min. B47-72 B81.5-85 B81.5 min. B82-88 B82 min. B78-84 B78 min. B82-88 B82 min. B80-88 B80 min.
Extrusion and Bar Stock	2024-T62 2024-T851X 6061-T6, T651X 7049/7149-T73 or T7351X 7075-T73, T735X 7075-T76, T765X	38-44 36-41 41.1-42.5  40-45 40-41 41.1-43  38-41 41.1-43  36-40	B72-83 B74.5 min. B74.5 min. B47-72 B81.5-85 B81.5 min. B78-84 B78 min. B82-88
Tubing	2024-T6X 2024-T81 5052-0 6061-T4X 6061-T6X	38-44 36-41 41.1-42.5  34-37 35-41 40-45	B72-83 B74.5 min. B74.5 min. H92 max. E60 min. B47-72
Casting	A356	N/A	E84-94

NOTE:

 This material shall be 100 percent hardness tested and approved if specified hardness requirement is met.

 Where X is specified in alloy temper, use same percent IACS and Rockwell Hardness values given for modifications to that number such as; 7075-T61, uses same values as 7075-T6X.

ORGANIZATIONAL, INTERMEDIATE, AND DEPOT MAINTENANCE

STRUCTURE REPAIR

GENERAL INFORMATION

WET LAYUP PATCH FABRICATION

This WP supersedes WP019 00, dated 1 January 1996.

Reference Material

None

Alphabetical Index

None

Record of Applicable Technical Directives

None

- | | |
|--|--|
| <div>1. All data in this WP was relocated. For wet layup and patch fabrication (A1-F18AC-SRM-250, WP 006 00) and for precured and cobonded wet layup</div> | <div>patch installation and removal (A1-F18AC-SRM-250, WP 007 00).</div> |
|--|--|

